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The Gift of  
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1898 to 1922

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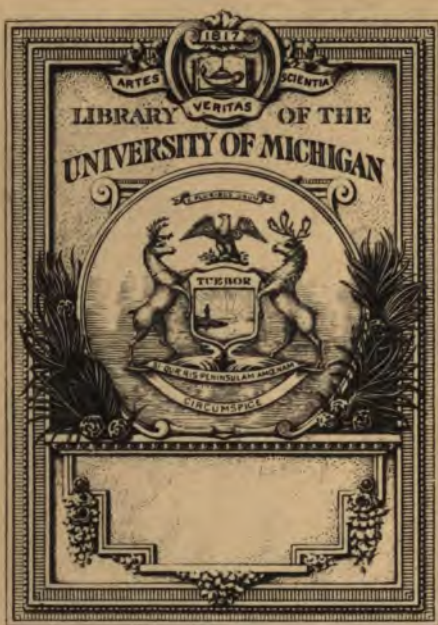
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Leighouren, William.

A N  
INTRODUCTION  
T O  
ASTRONOMY,  
Geography,  
NAVIGATION,  
And other  
MATHEMATICAL SCIENCES  
Made easie by the *Description* and *Uses* of  
the Cœlestial and Terrestrial GLOBES.

In Seven Parts.

CONTAINING

- I. The Definitions of the *Lines, Circles, &c.* upon the *Globe* or *Sphere*; and of several Terms of Art.
- II. The *Problems* in *Astronomy* Methodically digested, with Variety of *Examples*.
- III. The several Affections of *Triangles*, and their Solution upon the *Globe*; with the Variety of *Problems* which every *Cafe* contains.
- IV. The whole Art of *Dyalling* demonstrated and performed two several ways.
- V. The Erection of an *Astrological Figure* of the Heavens, according to the several ways of the Ancient and Modern *Astrologers*.
- VI. & VII. The Explanation and Uses of the *Terrestrial Globe*, with a brief *Geographical* and *Hydrographical* Description of the *Earth* and *Water*. With several *Problems* useful in the Art of *Geography, Navigation*.  
And also, The Description and Use of *Maps* and *Charts* both General and Particular.

By ROBERT MORDEN.

L O N D O N, Printed for R. Morden, at the *Atlas* in *Cornehil*;  
and R. Smith, under the *Piazza's* of the Royal Exchange, 1702.



Gift  
Professor William H. Burt  
10-14-1931

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THE  
PUBLISHER  
TO THE  
READER.

2-25-39 ACW  
THE principal Glory of the Mathematical Sciences, is their Certainty, whereby they are able to command the Approbation of others, and impose upon their Adversaries a Necessity of favouring their Demonstrations; and of these *ARITHMETICK* and *GEOMETRY* have the Preheminence. But *COSMOGRAPHY* deriving her Current from more abstruse and hidden Fountains, hath left a harder Task to her Observers to find her out, and trace her through her curions Labyrinths.

Notwithstanding the most necessary Care of worthy Authors hath scarcely in any Age been wanting, and *Urania* still found those who admir'd and celebrated her Excellencies.

The

## *The Preface.*

The Subject of this Treatise therefore being *Cosmography*, needs no Commendation, where there are Noble Men or Noble Minds : Wherefore all I shall say of *Astronomy* is, That 'tis of such important Consequence, that without the Science thereof, how great Uncertainty in Times and Seasons, what distracting Confusions in Human Affairs, must we necessarily be involv'd in ? And for *Geography*, all that need to be spoken of it is, That 'tis so Noble a Study, and of such grand Importance, as Kings and Princes have made it their highest Concern to understand it, as well for the Improvement of all Naval Knowledge, and necessary Advantages of Maritime Commerce and Trade ; As for that the Acquisitions of all Martial and Regal Dominion depends thereon. Wherefore, that the one might be the more easily apprehended, and the other more truly represented to our View and Fancy, the Ancients, with the Consent of succeeding Ages, have with much Pains and Industry not only invented, but also commended to Posterity the Sphere and Globe, of whose Excellency all I shall say, is, That they have the Priority in Nature of all other Instruments, as most fit and convenient to the understanding and fancy, analogically representing the Heavens and the Earth, in their proper genuine Figures ; and therefore ought indeed to be the first Study a  
Learner

## *The Preface.*

Learner should undertake : for without a competent Knowledge of them, he will not be able to understand well any Author in other Mathematical Sciences.

I cannot conclude without saying one Word or two concerning *Globes*, the Subject of this Treatise. 'Tis now about 50 Years ago since Mr. *Joseph Moxon* made a new Size of Globes about 14 Inches Diameter ; and in his Book of the *Use of the Globes* he tells us, That he had the Help and Assistance of the ablest Mathematicians in *England* and *Holland*, and are still cryed up by some for the best and latest Globes in *England*. Give me leave only to acquaint my Reader, and others whom it may concern, That some Years after I publish'd a Pair of Globes about the same Size, wherein I then corrected these, and many other notorious Errors : Not to insist much upon the Cælestial Globe, wherein all the Stars must necessarily have been out a whole Degree in Longitude, in Right Ascension and Declination some much more : But in the designing of the Terrestrial Globe. I was obliged to alter many places in *Europe* two or three Degrees of Latitude, and more than five in Longitude. To rectifie some places in *Asia* 10 Degrees in Latitude, and as much in Longitude. In *Africa* and *America* almost the same, and also to insert several eminent

A 3      Countries,



## *The Preface.*

Countries, Cities, Rivers, &c. wholly omitted in his. But the general Commendation my Globes have had from worthy and learned Gentlemen, and the kind Reception they have found at the two most Learned Universities of the World, beyond those old Erroneous Globes, may justly command my Silence, had it not been for a Reason. *Vide N. 32. in Geography made easie.*

I had almost forgot to have acquainted my Reader, That about the same time I published also a Book for the Use of them, the Problems being written by Mr. *Wm Leybourn*, which having been long since out of Print, although much enquired after, as being the best Treatise of the Globes extant, is now again revived, being much Corrected and Improved with many Additions. My only Design hereby is, That it may be useful to excite and encourage such as for want of a plain and easie Introduction, are content to be ignorant and careless of these so excellent Sciences: And that it may to young Students give them such useful Notions, as may induce them with the more Ease and Pleasure to advance into the Study of deeper and larger Mathematical Contemplations; which is the real Desire of

*R. Morden.*

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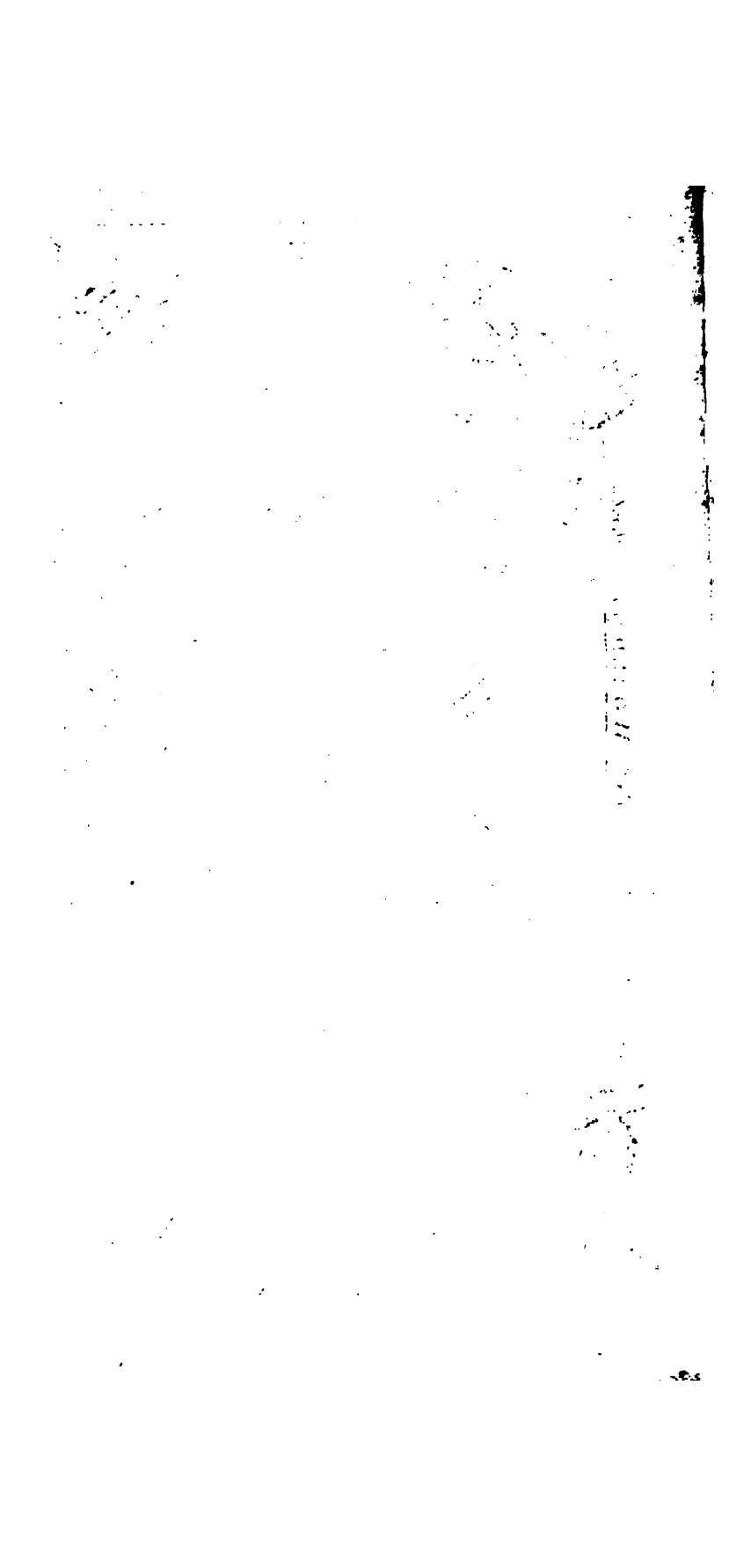
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A NEW MAP of <sup>e</sup>WORLD by Rob<sup>t</sup> Morden.



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Astronomical Definitions.

Containing the

RUDIMENTS

OF

ASTRONOMY,

AND

EXPLANATION

OF THE

*Sphere and Globe.*

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INTRODUCTION.

**W**Hatsoever is to be known of the Order, Situation and Motion of the great Bodies of the World, is all to be found out, by the Observation of Celestial Appearances; amongst which the first, chiefest and most known, is that by which we see the Sun, Moon and all the Stars, in every



## 2 INTRODUCTION.

24 Hours, to be mov'd about the Earth from East to West; and this by Astronomers is call'd the first or *Diurnal Motion*, to distinguish it from the second or *Annual Motion*, which the Sun, Moon, and all the Planets are observed differently to perform from E. to W.

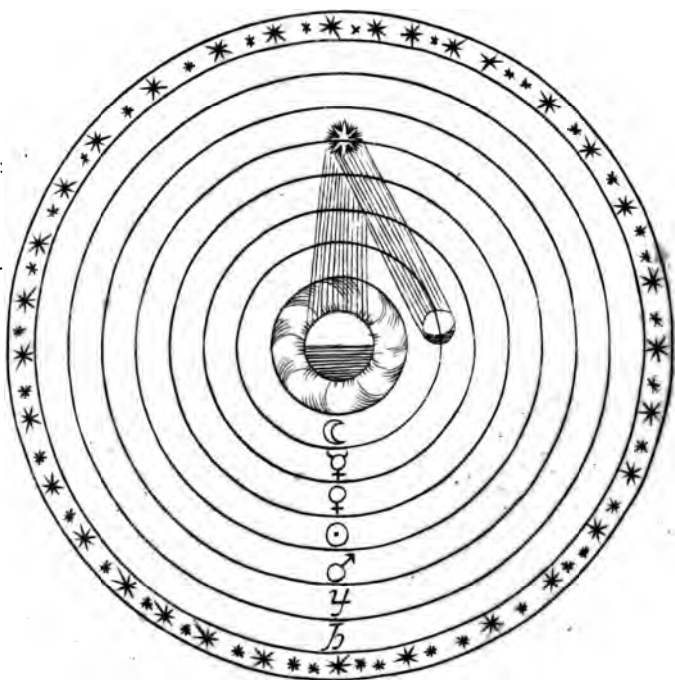
Besides the Eclipses of the Sun and Moon, there is observed in the other five Planets, that they are not always direct, that is they do not always move according to the Course of the Signs; but sometimes *Retrograde*, that is, they go back, and sometimes are *Stationary*, that is seen to stay at the same fixed Star: Also, that they go more, sometimes less to the North and South, and particularly that the Superiour Planets, viz. ♃, ♄ and ♀ turn from the Sun even to an Opposition, and that then they are always Retrograde, and greatest in Aspect. But the Inferiours, viz. ♁ and ♀ do not depart far from the Sun; ♁, little more than one Sign and a half; ♀, indeed not a whole Sign, and therefore that they sometimes go before, sometimes follow after the Sun, &c.

Many various Ways were Invented by the Ancient Philosophers, that they might Explicate the Phænomena or Appêarances of this variety of Motions; some introduced Circles concentrick, having the same Center to the Earth, with many Epicycles or lesser Circles: Others, Circles Excentrick with only one Epicycle. One supposed the Earth to move; Another made the Sun; the Author of the first was *Pythagoras*, the Disciple of *Pherécides*; of the latter, *Anaximander*, Scholar to *Thales*: both of them lived in the Time of *Cyrus*, King of the *Persians*, about 550 Years before Christ was born. The Followers of *Pythagoras* were *Phylolaus*, *Ecphantus*, *Heraclides of Pontus*, *Aristarchus*





*Ptolomean Sphere*



## I N T R O D U C T I O N. 3

*starchus* of *Samos*, and the more mature *Plato*. Of *Anaximander*, *Anaxagoras*, *Democritus*, *Eudoxus*, *Calippus*, *Aristotle*, *Hipparchus* and *Ptolemy*, who *Ann. Dom.* 140. much improved it; so that it took place in the Schools 1400 Years, and was called the *Ptolemean* or *Aristotelian* Systeme.

### *A Description of the Ptolemean System.*

This System of the Heavens, and the Motion of the Planets, supposeth the Earth to be fixed in the Center immoveable, and that all the Celestial Bodies do move round it in their Diurnal and Annual Revolution. This System or Hypothesis the Ancients supposed to be divided into two Parts or Regions, *Elemental* and *Celestial*. The first consisted of four Parts: 1<sup>st</sup>. The *Earth*; 2<sup>ly</sup>. The *Water*, which together make one perfect Body. Above these are the other two Elements, viz. 3<sup>ly</sup>. The *Air*; and above that 4<sup>ly</sup>. *Fire*. The second consisted of many Parts, viz. 1<sup>st</sup>. The *Moon*, 2. *Mercury*, 3. *Venus*, 4. The *Sun*, 5. *Mars*, 6. *Jupiter*, 7. *Saturn*, 8. the *Orb* or *Sphere* of the *Starry Heaven*: All which Orbs or Circles, were imagined to be carried about upon the Axis of the World, from E. to W. in 24 Hours, by the rapture of the *Primum Mobile*. See *Fig. I.*

Besides this Diurnal Motion, by which the Planets and Stars are carried round about from E. to W. in 24 Hours, by the rapture of the *Primum Mobile* upon the Poles of the World, they are supposed to have also a free and proper Motion of their own from W. to E. according to the Succession of the Signs; upon or near to the Poles of the *Ecliptick*, each of them in a several manner and space of Time, viz. the *Moon* in 27 d. and almost

#### 4 INTRODUCTION.

8 h; *Mercury*, in 88 d; *Venus*, which in her preceding the Sun is called *Lucifer*, but in her following of the Sun is called the Evening Star, in 22 days; The Sun, in a Year, or 365 d. and almost 6 Hours; *Mars*, in 321 days; *Jupiter*, in 11 Year, 10 Months and 16 Days; *Saturn*, in 29 Years, 5 Months, 15 Days.

#### *Of the Copernican System.*

This Hypothesis seemed unreasonable to the *Pythagoreans*; and therefore they divided another System of the World, which *Nich. Copernicus* of *Thorn* in *Prussia*, who lived about the Year 1536. A. C. revived and improved the long neglected System of the World, excogitated by *Pythagoras*, as afore said. See Fig. II.

#### *The Principles of which Hypothesis are these;*

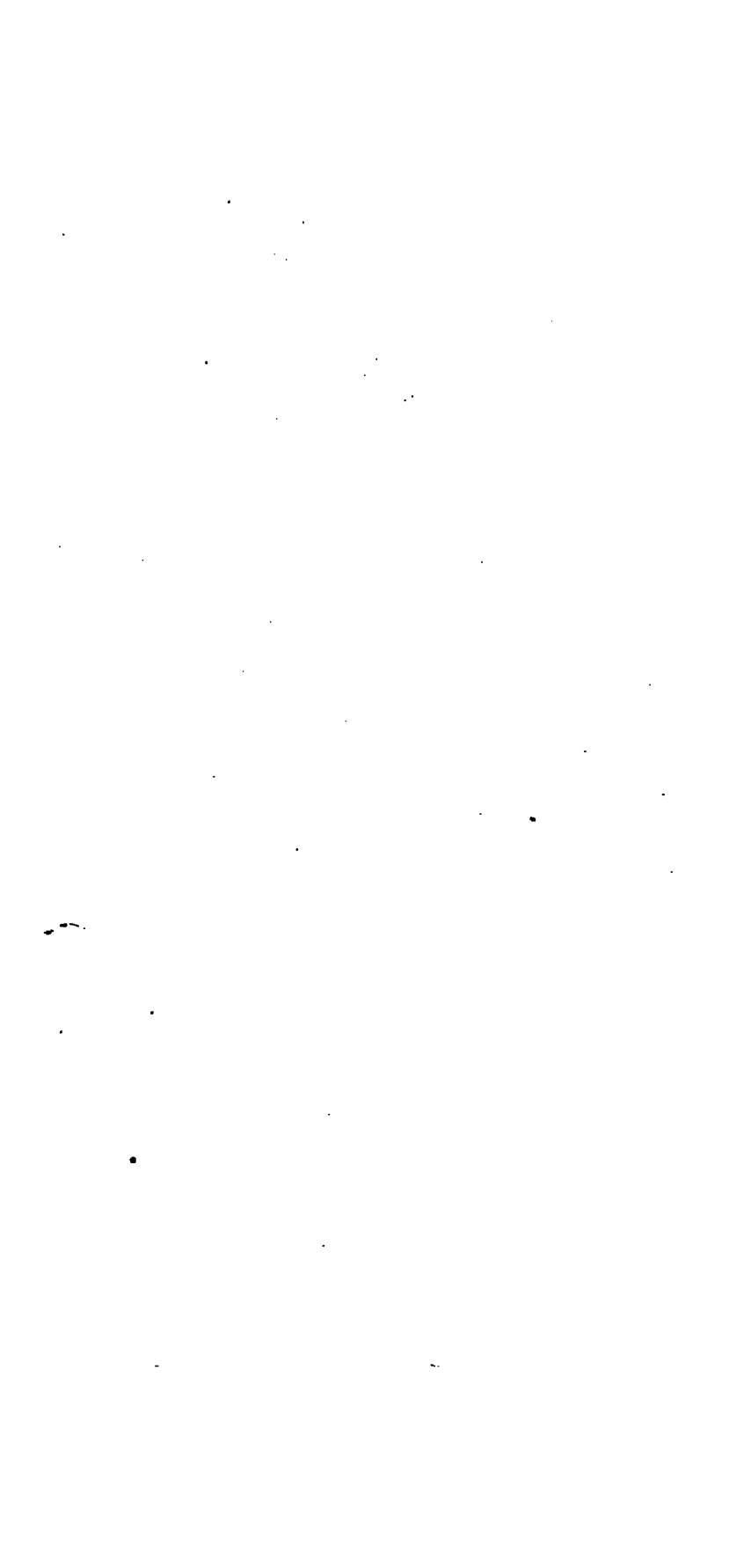
1. The Sun is placed in the Middle or Center of the World, and of all the Planets, and hath no Circular Motion, but only Central upon its own Axis; which is performed from W. to E. in 25 Days, 9 Hours and a half.

2. That the Sun by his Rotation on his Axis makes all the Body of Fluid either in this our *Vortex* or Planetary World, and the Planetary Bodies therein posited by Vertue thereof, to be all carried about the Sun, from the W. to E. as their proper Center, not in perfect Circles, but Elliptick Paths or Orbs, every one in time exactly proportional to the Magnitude of his Orb and Distance from the Sun: So are the secondary about the Primary in their proper Centers, also in Elliptick Orbs, every one in time proportional to their distance from their primary Planet, or Center of their Vortices.

# Copernican *Paradis* System.

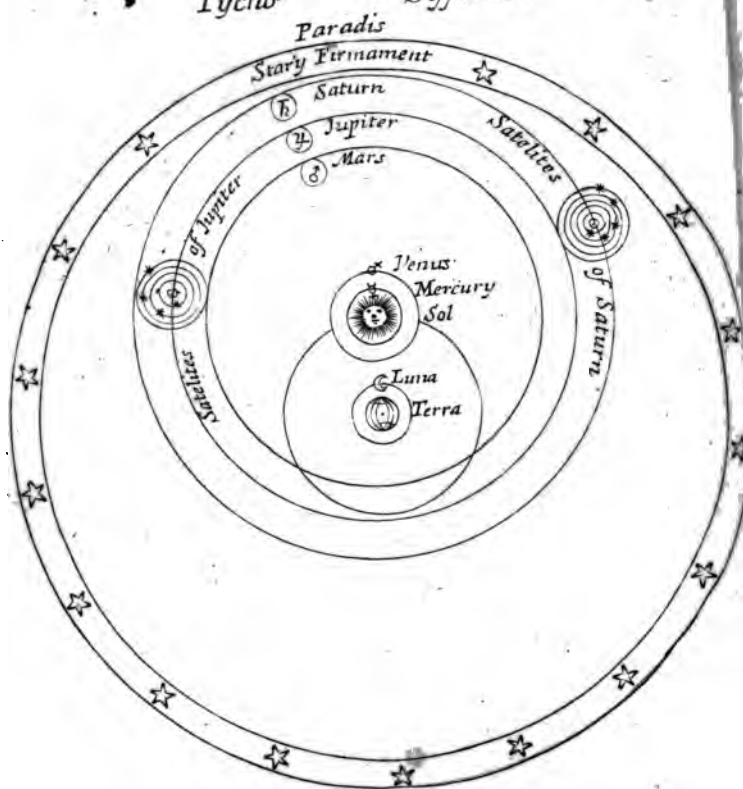


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# Tycho's System.





## I N T R O D U C T I O N 5

3<sup>ly</sup>. That the Earth is one of the Planets, having a two fold Motion, the Diurnal upon its own Axis in 24 Hours; from East to West; whereby all its parts are alternately enlightned and day and night, Successively enjoyed. And her Annual Motion about the Sun, which is made upon the Poles of the Ecliptick, betwixt the Orbs of ♂ and ♀ whereby all places by course enjoy *Spring, Summer, Autumn, and Winter*. And that the Moon is moved about the Earth, as her Center; where by reason of the annual Motion of the Earth, she hath not only relation to the Earth, but by consequence to the Sun, as the other Planets have.

4<sup>ly</sup>. That as the Earth is environed with the Sphere of the Moon, so are some, if not all, the other primary Planets in like manner encompassed with their Moons, or concomitants; as Jupiter his *Satellites* or Circumjovials, and Saturn his Ring, &c.

5<sup>ly</sup>. That by the Diurnal motion of the Earth, the vast motion of the Stars, and *primum mobile*, is taken away; and by the Annual, the Epicycles of the Superiors, and the Fictitious Excentricks of the Inferiors are abolished: likewise all *Anomalies* (or Irregularity) in their Motion, as to Longitude and Latitude, whether Stationary or Retrograde cease, and most exactly answers all appearances.

### *Of the Tychonian System.*

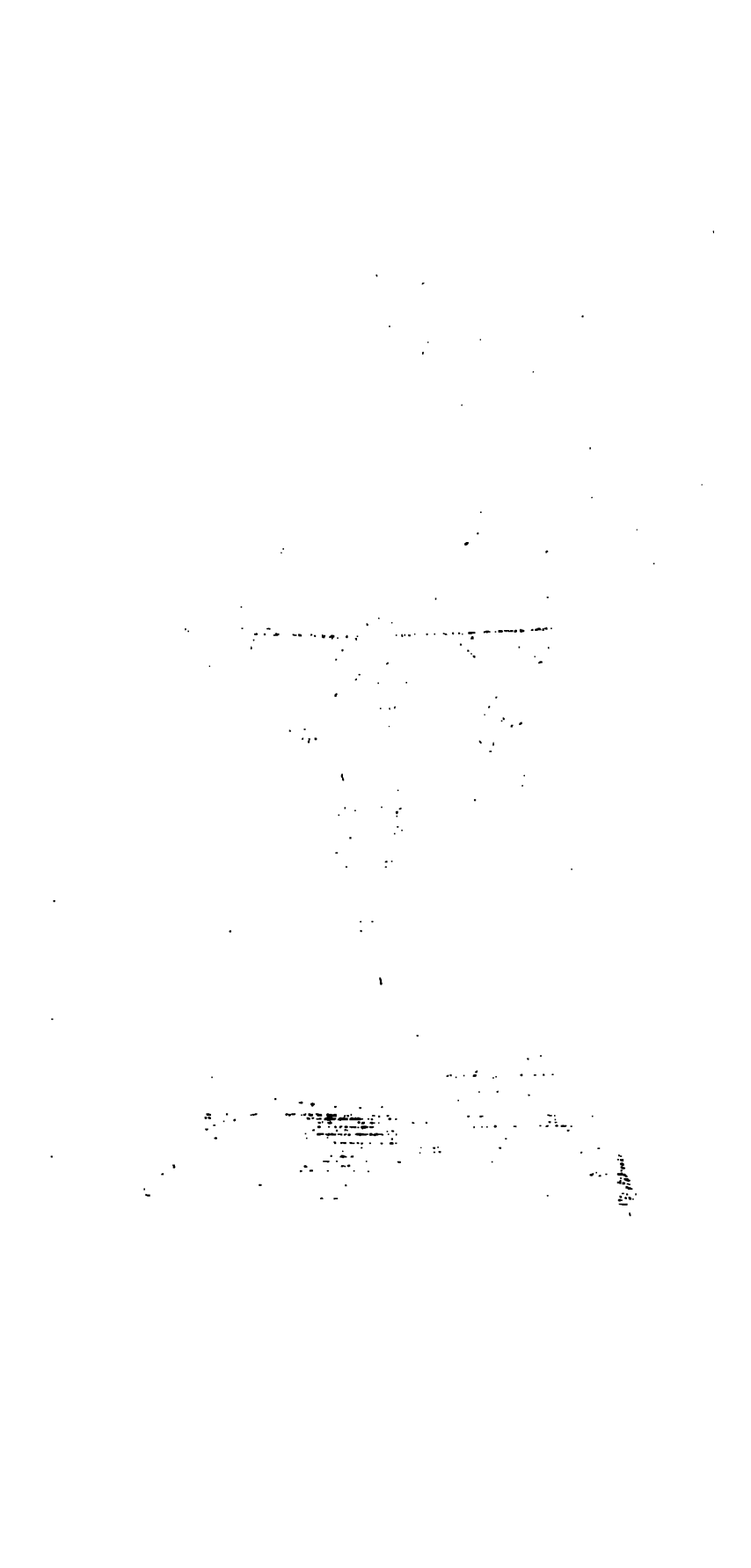
But *Tycho Brahe* the noble Dane, who with an Heroical bravery, enterprised no less than the Instauration of the whole Science of Astronomy, disliking the Epicycles of *Ptolemy*, and the two-fold Motion of the Earth, according to *Copernicus*, proposed another System of the World, placing the Earth in the Center of the Moon,

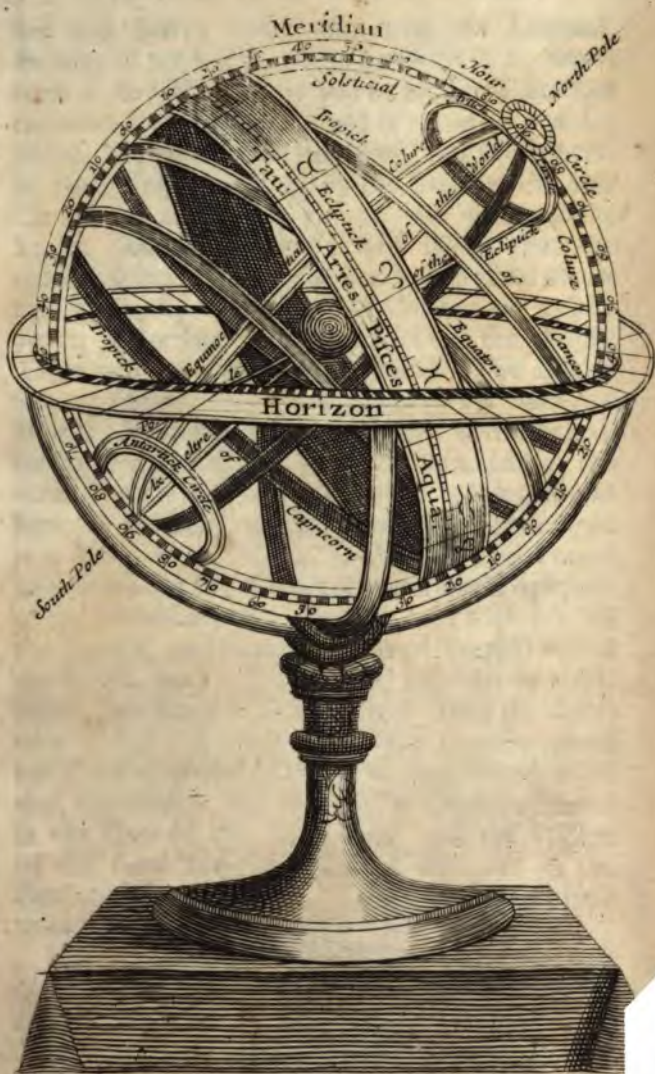


## 6 INTRODUCTION.

Sun and Starry Orb; admitting the Diurnal, *Rotation* of the Earth, about her Axis in 24 Hours from E. to VV. But the Sun to be the Center, of the other five Planets, instead of a *primum Mobile*; yet so, as that not the Inferiour, but the Superior Planets only, encompass the Earth with their Circles; so that *Mars*, is sometime nearer to the Earth, than to the Sun. And lastly, that the remote Sphere of the fixed Stars, is carried about the Earth, by a most slow Motion of 25412 years, according to the Series of the Signs. Therefore to those three bodies The Moon, Sun and Stars, there really belongs but only one Simple Motion, and that Spiral or Elliptical, towards the West. But to the Sun, and all the other Planets (except the Moon) moving round him, he supposed carried about the Earth once in a Year, from W. to E. By this contrivance he avoided the Imputation of that absur'd opinion; of the *Ptolemeans*, that the Sun, and with him all the Planets, and fixed Stars, were carried round the Earth, once a Day. And also that he attributed, less Motion to the Earth, then the *Copernicans*; and that never the less the appearances of the Planets, would be as well represented as in that *Hypothesis*. But should the Earth be moved in the Place of the *Solar Circle*, and the Sphere of the fixed Stars adapted to the Sun as the Center, This *Tychonick*, would plainly appear to be the *Copernican System*. See *Fig. III*.

However, that the knowledge of *Astronomy* and *Geography*, might be the more easily apprehended, and truly represented to our view and fancy; The Ancients, with the consent of succeeding Ages have with much pains and Industry, not only invented, but also commended to posterity the *Sphere or Globe*. Astr





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Astronomical Definitions.

Containing the

RUDIMENTS

OF

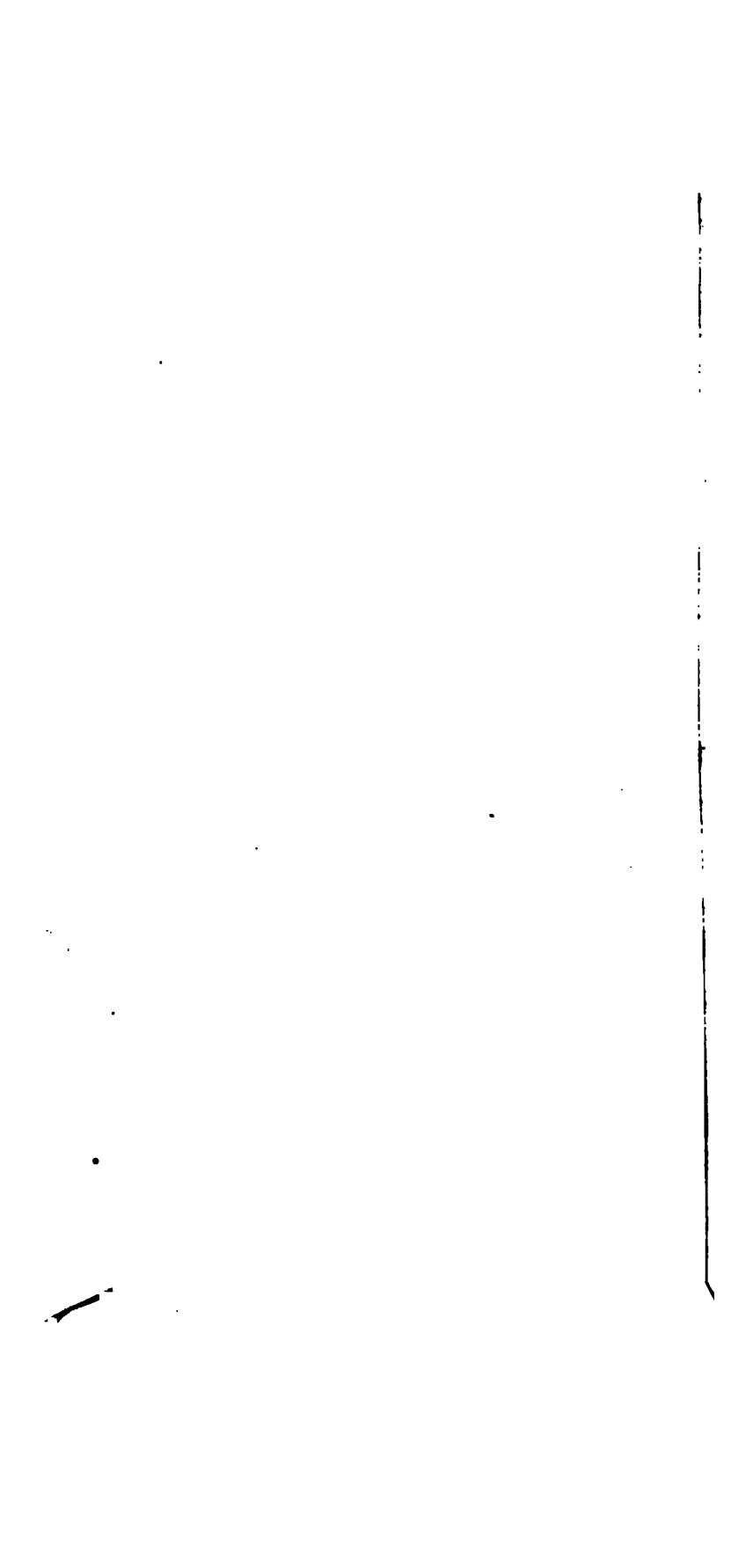
*ASTRONOMY, &c.*

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*What a Sphere is.*

**A** *Material, or Armillary Sphere, (Omitting the Geometrical Definition of a Sphere) in relation to my present purpose is, An Astronomical Instrument made of several Circles, so fitted together, as thereby the better to express and represent to the Fancy the Motions and appearances of the Celestial bodies, according to either the Ptolemean or Copernican Hypothesis.*

These Material Spheres either in Wood or Brass, are now more exactly made and better contrived than any formerly done, and may be procured at a more reasonable rate; and in operation may be applied to practical Uses, as the Globe is.







*Astronomical Definitions.*

contains 60', 3600'', 216000'', 12960000'''. So that when we speak of a Degree, we mean the 360 part of a Circle great or Small.

The Reason why this Circle is divided into four Nineties, is because the Elevation of the Pole, or Latitude of any place cannot be above 90 Degrees.

The Uses of this Circle are, to find the Latitude of places, the Right Ascension and Declination of the Stars, and to Elevate the Globe to any Latitude.

*Of the Hour-Circle and Index.*

Upon the Brass *Meridian* is fitted a Small Brass Circle, whose Center is the Pole of the Globe, and is divided into 24 Equal parts; representing the Hours of the Day and Night; which in the Revolution of the Globe is pointed to with an *Index*, which is fitted to the Pole of the Globe. It's use is to shew the time of the Sun, Moon, or Stars rising and setting, and the time of the Day in any part of the World.

*Of the Quadrant of Altitude.*

There is also another appendant relating to the *Meridian*, called the Quadrant of Altitude, which is a Thin Brass Plate, divided into 90 equal parts or Degrees, and fitted with a Nut and a Screw to move to any Degree upon the *Meridian*. Its use is to measure Distances, Altitudes, and Limits *Azimuths* and *Almicantars*.

## Of the Wooden Horizon.

Besides the Body of the Globe, there is also annexed a Certain frame of wood which is called the *Horizon*; the upper plane whereof is a broad wooden Circle encompassing the Globe, having two Notches, the one in the *North*, the other in the *South* part; being made fit to contain the *Brazen Meridian*, that the Globe may move into any position; In the upper Plane whereof, are several Circles delineated. The First or inner Circle, is divided into 12 equal parts or Signs; every Sign having its Name, Nature, and Planet it governs placed to it: whose Names and Characters are, *Aries* the Ram ♈; *Taurus* the Bull ♉, *Gemini* The Twins ♊, *Cancer* the Crab ♋, *Leo* the Lion ♌, *Virgo* the Virgin ♍, *Libra* the Balance ♎, *Scorpio* the Scorpion ♏, *Sagittarius* the Archer ♐, *Capricornus* the Goat ♑, *Aquarius*, the water Man ♒, *Pisces* the Fishes ♓. And every Sign is again divided into 30 equal parts or Degrees, and numbered with 10, 20, 30.

Next to the Circle of Signs is a *Kalender* or *Almanack*, according to the old Stile used by us here in *England*, called the *Julian*; which is divided into the 12 Months of the Year, viz. *January*, *February*, &c. to *December*, every month being subdivided into its number of Days; whereunto is annexed the Names of the Festival days. Next is a *Kalender* of the New Stile, now used in many foreign places, Instituted by Pope *Gregory XIII.* in which the Months begin 10 days sooner than they do in the other. The Last is a Circle of the Winds, divided into 32 equal parts, called



called points of the Compass, according to the Number of winds which are observed by our modern *Navigators*; by which they design forth the Quarters of the Heavens, and the Coast and Bearings of Countries. The Use of the Upper plane of the *Horizon* is to distinguish the *day* from *night*, The *Rising* and *Setting* of the *Sun*, *Stars*, and *Planets*, and for the finding the *Azimuths*, *Amplitude*, *Twilight*, &c.

*Of the Semicircle of Position.*

This is a half Circle of Brass, fixed in the Intersection of the *Meridian* and *Horizon*. And is to move up and down between the *Meridian* and *Horizon*; and is divided from either end with 10, 20, 30, &c. to 90. And is chiefly used in *Astrology* and *Dialling*, and therefore is not usually sold with the Globes, unless desired.

*Of the Nautical Compass*

This is a Small round Box, about 2 Inches and a half Diameter, placed upon the *Basis* of the *Horizon*, wherein moves a Needle touched with a Loadstone, which directs to the N. and S. which points must be placed Parallel with the N. and S. Points of the *Horizon*. The Use of it is to place your E, W, N, and S. Points of the Globe, to correspond with those in the Heavens.

This much may serve for the Appendances circumjacent to the Body of the Globe: proceed we therefore to the.

*Celestial Globe.*

The Starry Heaven, that glorious Canopy, embroidered with those Sparkling Diamonds which hang upon the Dusky cheeks of the Night, as a rich Jewel in an *Aethiop's* Ear, is represented unto us by the *Celestial Globe*, because upon its Convexity are Artificially placed all the Stars and Constellations, Lines, Circles, and other Appearances, in that order and place as they are Naturally Situate in the Concavity of that Orb or Sphere.

*Of the Lines, Circles, &c. Delineated upon the Celestial Globe.*

For the better Understanding of the *Celestial Globe*, and for the more easy determinating the *Motions, Progressions, Distances, &c.* Of the Heavenly bodies, there are certain Imaginary Lines and Circles, conceived to be in the Concavity of the Heavens; and therefore Delineated upon the Surface of the *Celestial Globe*.

*Of the Equinoctial.*

This is a great Line encircling the Globe, equally distant from both the Poles; and divides the Globe into two Hemispheres: That next the N. Pole, is called the N. Hemisphere; the other next the South, the Southern Hemisphere. All places that lie under this Circle have a Perpetual *Equinox*, that is, days and Nights equal; for this Circle, in all positions of the Globe, except in a Parallel, is half above and half under the *Horizon*; when the Sun comes to this Circle, which is twice in the Year, he makes the Day and  
Night

Night equal to all the Inhabitants of the Earth, viz. in the beginning of *Aries*, which with us is about the 10th or 11th of *March*; and again in *Libra*, which is about the 12th or 13th of *September*. It is divided (as all great Circles are) into 360 Parts or Degrees, and each Degree subdivided into lesser Parts, called Minutes; and every Minute into 60 Seconds, and so to Thirds and Fourths, if such exactness be required. This Circle measureth the Quantity of *Artificial* and *Natural* days, hours &c. therefore its degrees are called *Tempora*, times; and is some times, upon the New Globes, divided into 24 hours, 15 degrees to one hour; for 15 times 24 makes 360 degrees; and every degree is 4 minutes, for 4 times 15 is 60 minutes, or one Hour: and therefore useful in making, and shewing the reason of *Sun-dials*. From this Circle to either Pole, we reckon the *Declination* of the *Sun* or *Star*, and the *Latitude* of *Places*: upon this Line also we number the *Right* and *Oblique Ascensions* of the *Sun* and *Stars*, and upon it we measure the *Longitude* of *Places*. It is the same Line with the *Equator*, upon the *Terrestrial Globe*, only that remains fixed and immoveable, this variable; or at least it must be imagined to move in the Heavens.

*Of the Motion of the Equinoctial.*

One of these two must needs be granted, either the Motion of the 8th Sphere or Starry Orb from W. to E. upon the Poles and Axis of the *Ecliptick*, or else the Progress of the *Equinoctial* points into the Precedent Signs. Now that the First is not to be admitted appears manifestly, because that  
the



the fixed Stars have not at all changed their Situation in respect of Latitude: Therefore the other must needs be granted *viz.* the Motion of the Equinoctial: Hence it comes to pass that the Stars move not, but are by the Proceſſion of the Equinox left behind the Equinoctial Colure; and alter their Longitudes. For the first Star of Aries which in the time of *Meton* the *Athenian* (who lived about 431 years before Christ's time) was in the very vernal Interſection: But in the year 1572 when *Tycho* observed it, 'twas found to be in  $27^{\circ}$ ,  $37'$  of *Aries*, and will according to his opinion finish its Revolution in 25412 years, which is above a Degree in 70 years: of which more hereafter.

#### Of the Ecliptick.

This is a great Circle intersecting the Equinoctial at *Oblique Angles* in  $\gamma$  and  $\omega$ , and declining from it  $23^{\circ}$ ,  $30'$  towards each pole of the World, so that it toucheth the *Tropicks* in  $\odot$  and  $\varpi$ ; And whose Poles are Consequently  $23^{\circ}$ ,  $30'$  from the Poles of the World. This Circle divides the Globe into two Equal parts called *Hemispheres*, the one *Northern*, the other *Southern*, according to their position next to the N. or S. Pole of the World.

This Circle is divided into 12 equal parts, which are called the 12 Signs, whose Names and Characters [*Vide Horizon*] called also *Dodecatemoria*, the Signs of the Zodiack being marked with the Figure, Character and Name of the Sign belonging to it: and each of these Signs are divided into 30 equal parts called Degrees. The whole containing  $360^{\circ}$ .

So that when any thing is said to be in such a Sign, whether a fixed Star, a Wandering Planet, or New appearing Comet, it is Included in one of the 12 parts which arise from the aforesaid Division of the Heavens : And so in this sense the Sun, or the Sun's place is said to be in such a Sign ; as  $\gamma$ ,  $\delta$  &c. by the Greeks, who in their Language call a living Creature ζῷον or ζῷδιον for every Sign except one is a living Creature : Others will have it so called of ζῷν Life because the Sun's motion under it procureth Life unto living Creatures. Under this Line the Sun and the rest of the Planets finish their several Revolutions the Sun directly under it, but the rest of the Planets have all of them their Latitudes and deviations from this Line, by reason of which their digressions and Extravagancies, the Ancients assigned the Ecliptick 12 degrees of Breadth : but modern Astronomers by reason of the Evagations of *Mars* and the Moon, have added to each side two degrees more so ; that the whole Latitude is confined to 16 degrees which breadth is called the Zodiack.

As all the Meridians describ'd upon the Terrestrial Globe meet in the Poles of the World, So all the Circles of Longitude, being drawn through the 12 Signs in the *Celestial* Globe, meet in the Poles of the Ecliptick ; upon which Poles, the Sun and Planets move according to their proper motion from W. to E. contrary to their diurnal motion on the Poles of the World from E. to W.

The Use of this Circle is to shew unto us the place and Annual motion of the Sun : upon it we reckon the Longitude of the Stars ; and from it we

we count their Latitudes. The Year, the Months, and the 4 Seasons of the Year are determined by it. And under it we see the Defects and Eclipses of the Sun and Moon.

*Of the Colures.*

So called from two Greek words Κόλος, or Κολός, *Mancus*, maimed or defective, and οὐρά, *Cauda*, a Tail; because in an Oblique Sphere they have some part unseen, as if they were maimed or wanting. They are two great Circles cutting one another at right Angles in the Poles of the World; The one passing by the beginning of *Aries* and *Libra*, two Equinoctial Signs, and is therefore called the *Equinoctial Colure*; The other passing through *Cancer* and *Capricorn*, two Solstitial Signs, and is therefore called the *Solstitial Colure*, from *Solstice*, *solis statio*, because the Sun seems to stand. This Colure passeth through the Poles of the World, and also of the Ecliptick; but the other passeth through the Poles of the World only. These Colures divide the Ecliptick into four equal Parts, viz. into *Aries*, *Cancer*, *Libra* and *Capricorn*, which are called the *Cardinal Points*: for according to the Sun's entrance into them, the Season of the Year is altered; for at the Sun's entrance into ♈, which is about the Tenth of *March*, till he comes into ♋ about the Tenth of *June*, makes Spring, from thence to ♊ about the Thirteenth of *September* is Summer, from thence to ♏ about the Eleventh or Twelfth of *December* makes Autumn, from thence to ♏ again makes Winter.

The Graduation of the Colures in the Celestial Globe, is generally omitted in most Globes. But



if the Equinoctial Colure were graduated from the Equinoctial towards each Pole of the World, and the Solstitial Colure graduated from the Ecliptick towards each Pole thereof; the Declinations and Latitudes of the Stars: The Resolutions of Spherical Triangles, would be much more plain and easily performed by the Globe.

*Of the Tropicks.*

Twenty three Degrees and a half from the Equinoctial or the Equator, there are two smaller Parallel Circles which are called *Tropicks*, and are the bounds of the Ecliptick. That on the North side of the Ecliptick is called *the Tropick of Cancer*, where the Sun hath the greatest North Declination, and makes our longest Day and shortest Night, which is about the 11th of *June*. The Other on the South side of the Equinoctial is called *the Tropick of Capricorn*, in which Point the Sun hath its greatest Southern Declination, making our shortest Day, and longest Night; which is about the 11th or 12th of *December*.

*Of the Arctick and Antarctick Circles.*

At the same distance from the Poles of the World as the Tropicks have from the Equinoctial Circle, and the Poles of the Ecliptick from the Poles of the World, viz. 23 deg. 30 min. are described two small Parallel Circles: That near the North Pole, is called the *Arctick Circle*; the Other in the South, is called the *Antarctick Circle*.

The Ancient Greek Authors, and some of the Latine also, assigned no certain distance to these Circles from the Poles: but made them various and mutable according to the diversity of the  
Eleva-

Elevation of the Pole, or divers Position of the Sphere ; and therefore defined the *Arctick Circle* to be the greatest of all those Circles which are always in sight, and toucheth the Horizon in one Point, and is seen all above the Earth ; and the *Antarctick Circle* to be equal and parallel to it, and lie wholly under the Earth.

And thus much may serve for the Imaginary Lines and Circles conceived to be in the Concavity of the Heavens, *Vid.* Fig. VI. Proceed we therefore to speak

*Of the Starry Heaven.*

This is the most Noble Part of the Universe, in which (encircling the Terrestrial Orb at unmeasurable distances) sparkle the innumerable Lights or Stars, in the immense expansion of the Firmament. These Celestial Lights are either fixed as the Stars, or Erratick as the Planets.

*Of the fixed Stars.*

These are said to be fixed, because they always keep (at least to our sight) the same invariable distance from one another, and from the Ecliptick, as if they were so many Lucid Points fixed in the Celestial Firmament.

*Of their Substance.*

The Opinion of Philosophers concerning this are Various : Some thought them to be of a fiery Nature ; Others to be partly earthy and partly fiery : Some conceived them to be of the same Matter as Exhalations and Vapours, partly aqueous,



ous, partly aerial. Our Modern Astronomers suppose them to be compounded of Elementary Matter formed into fiery Globes, partly liquid and partly solid ; the liquid being fluid and moveable like flame.

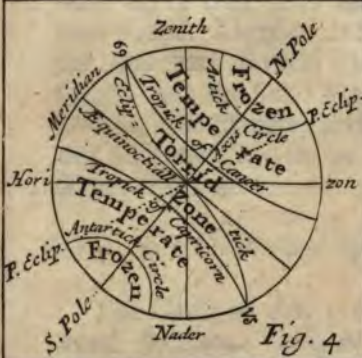
*Of their Light.*

Though many Phylologers have thought their Light to be borrow'd from the Sun, yet most now agree that it is innate, shining with their own proper Light as doth the Sun : And that as the Sun hath several Planets carried about him, so also that the fixed Stars have other Mundane Bodies, like Planets moving about them, though not discerned by us, by reason of their vast distance from us.

*Of their Scintillation.*

The Cause of this is variously hinted at by several Authors. *Aristotle* assigns the Cause thereof to their Remoteness from our sight, by which they are weakly, and as it were by a trembling weariness reached to our Eyes. Others ascribe the Cause thereof to Refractions, and therefore say, that *Sirius* and *Procyon* twinkle or glimmer more than any of the rest; because they never ascend above 45 deg. above the Horizon. Some suppose it to be from their quick and swift Motion about their own Axis, by that means making a more sudden Variation in those Radiant Objects than the Eye can pursue. *Gassendus* conceives this twinkling of the fixed Stars to be from that innate Light they are indued with, like that of the Sun, sparkling and casting forth such quick  
darted





*A Oblique Sphere*



*A Direct Sphere*



*A Parallel Sphere*



darted Rays, as our weak sight cannot behold them without that trembling Passion. *Hevelius* rather imputes their twinkling to a Constant Evibration of Lucid Matter, or a continual Expiration of fiery Vapours, or *Effluvia* from their Celestial Bodies; in the same manner as the Fulgurations and Ebullitions in the Body of the Sun. To conclude, in this they are particularly distinguished from the Planets, which have no such twinkling or glimmering Light.

*Of their Number.*

If we consider them only which are most notable and visible, and as they are reduced to 6 degrees or sizes of Magnitude, besides the *Nebulosa* or obscure, we shall find them according to *Ptolemy* to be 1026. *Pliny* reckon'd them to 1600. *Copernicus* 1022. The noble *Tycho* observed in his Horizon 773; to which *Kepler* in his *Rudolphine Tables* added 374, which made 1147. *Ricciolus* in his Catalogue sets down 1468. *Bartschius* tells us that *Bayers* in his *Uranometria* has 1725. The Number of stars observed by *Hevelius* at *Dantzick*, and Mr. *Halley* at the Isle of *St. Helena*, were 1888. But if we reflect upon the absolute Number of all the Stars, we may conclude them to be innumerable. *Galileus* tells us, that by his Telescope he discovered in the Asterism of the *Pleiades* above 40 Stars; and in the space between the Girdle and Sword of *Orion*, no fewer than 80 Stars; and in little more than one Degree's space, in the Constellation of *Orion*, above 500 Stars: According to which proportion of *Galileus's* Observation, there would be found at least 62500 Stars in that Constellation; whereas by the bare



Eye, there cannot be discerned above 63. And *Antonius Maria de Reitha* in his *Rudio Sydereo mystic.* affirms that in the same Constellation he hath distinguished above 2000 stars : So that if the rest of the Constellations were also observed, the Number of Stars appearing by the Telescope, besides what is discovered by the bare Eye, is computed to be above 1000000 stars, or rather infinite in Number.

*Of their Distance.*

Far remote in this *Carulean* Concameration of Stars, not well known whether in one Sphere or in several Distances, some vastly remote from others : So that this Universe of the Stars, is wholly undeterminable and incomprehensible both to our Sense and Imagination, no Limits thereof being any where to be perceived ; for looking with larger or better Telescopes, still more and more Stars appear : Yet the Earth's Annual Orb had a sensible Parallax to the Star in the Head of *Draco*, which, according to Dr. *Hook's* Observation, was 27'' or 30'' Seconds in the Winter Solstice, nigher to the Vertical Point of *Gresham College*, than in the Summer : so that the distance of the Star from the Earth was 13742 Semidiameters of the Earth's Orb : but whereas that Star was of the Third Magnitude, therefore those that are greater and nigher unto us, have also a greater Parallax ; so that allowing the Parallax of the Earth's Orb to the Stars, to be only 8'' or 9'' their distance from the Earth will be 28000 Semidiameters of the *Orbis Magnus*, or 385144200 Semidiameters of the Earth. *Peter Megirlinus* Professor of the Mathematicks in the Academy of *Basel*, in his *Systema Mundi*

*Mundi Copernicanum*, &c. from the aforefaid Observation of Dr. *Hook*, ſtates the diſtance of the fixed Stars from the Syſtem of the Planets, 5069 Semidiameters of the Annual Orb; every one of which contains 12 millions of *German* miles: ſo that the whole diſtance of the fixed Stars contains above 60000 Millions of *German* miles. *Ricciolus* tell us of five ſeveral ways of attaining in ſome probability, the knowledge of their diſtances, and makes the leaſt Diſtance to amount to 210000 Semidiameters of the Earth; the greateſt being altogether uncertain by reaſon of the profundity of their Orbs not to be determined. *Galileus* makes their diſtances 13 046 400 Semidiameters from the Earth. And according to *Copernicus* ſuppoſing the greateſt parallax  $10''$ , the Diſtance of the Stars from the Earth is, 47 439 800 Semidiameters of the Earth: And the Diſtance of the Sun from the Earth 1150. *Kepler* made their diſtance to be 142 746 428. *Vondelinus* 604 589 312 Semidiameters of the Earth; but doubtleſs the Diſtances of the fixed Stars, are as divers as thoſe of the Planets, and cannot be found out by any humane obſervation.

*Of their Magnitudes.*

Some of the Ancient Stoical Philoſophers thought, that the difference of the Luſtre and magnitude of the Stars did proceed from their diverſity of Situation, as more or leſs remote from our ſight: of this opinion was *Manilius*, who gives this reaſon, why ſome Stars in *Orion*, appear more obſcure then the reſt, *non quod clara Minus, ſed quod magis alta recedunt*. Theſe magnitudes are various, according to the

supposed distances of the Earth, set down by several Astronomers. First from the Observation of *Ricciolus*.

The greatest distance of a Star from the Earth being supposed to be 210000 Semidiameters of the Earth.

The Body of a Star of the	$\left\{ \begin{array}{l} \text{First} \\ \text{Second} \\ \text{Third} \\ \text{Fourth} \\ \text{Fifth} \\ \text{Sixth} \end{array} \right\}$	Contains the Earth's Body	$\left\{ \begin{array}{l} 3932 \\ 1220 \\ 260 \\ 216 \\ 92 \\ 64 \end{array} \right\}$

The Dia- meter of a Star	$\left\{ \begin{array}{l} \text{Contains} \\ \text{the Earth's} \\ \text{Diameter} \end{array} \right\}$	$\left\{ \begin{array}{l} 16 \frac{1}{2} \\ 11 \ 0 \\ 7 \ 3 \\ 6 \ 10 \\ 4 \ \frac{4}{5} \\ 4 \ 0 \end{array} \right\}$	Apparent Diameter being	$\left\{ \begin{array}{l} 16 \ 42 \\ 11 \ 0 \\ 7 \ 3 \\ 6 \ 10 \\ 4 \ \frac{4}{5} \\ 4 \ 0 \end{array} \right\}$

But for as much as the *Copernicans* opinion, makes the magnitudes of the fixed Stars, to be far greater; I shall give you the Magnitude of one, of the first Magnitude, *viz.* *Syrus*, and one of the least, *viz.* *Alcor*, according to *Galilaus*, and *Kepler*, supposing the apparent *Diameter*, of *Syrus* to be 18'', of *Alcor*, 4'', The Parallax made by the Earths motion, not to exceed 10'', and the Distance of the Stars from the Earth to be 142 746 428, Semidiameters from the Earth: Then the Body of *Syrus*, will contain the Body of the Earth, according

to

		$\left. \begin{array}{l} \text{and the Di-} \\ \text{ameter of Si-} \\ \text{rius to con-} \\ \text{tain the Di-} \\ \text{ameter of the} \\ \text{Earth.} \end{array} \right\}$	
to	Galileus, 82427672000		4380
	Kepler, 1367656371000	2550	

And the Body of *Alcor* to contain the Body of the Earth according

		$\left. \begin{array}{l} \text{And the Dia-} \\ \text{meter of } Alcor \\ \text{to contain the} \\ \text{Diameter of} \\ \text{the Earth.} \end{array} \right\}$	
to	Galileus, 9155362688		2092
	Kepler, 216000000000	6000	

These Magnitudes may seem strange to some; the Investigation whereof is a Work very difficult, if not beyond Humane Comprehension.

But for the better Distinction of the bigness of the Stars, they are divided into 6 Degrees of Magnitude: The biggest and brightest are called Stars of the First magnitude: Those next Inferiour in bigness and brightness, are called Stars of the Second magnitude; and so they gradually decrease to the Sixth magnitude, which is the Smallest; except some few, which are called occult, or Cloudy, or *Nebulosa*: And these several magnitudes are expressed on the Globe in several Shapes, as may be seen in a Small Table placed for that purpose, on the *Celestial Globe*.



*Of the Images or Figures called Constellations drawn upon the Celestial Globe.*

Dr. Hood tells us, That the Stars were brought into Constellations for Instruction's sake : Things cannot be taught without Names ; to give a Name to every Star, had been troublesome for the Master to devise, and for the Scholar to remember : Therefore the Ancients have reduced many Stars into one Constellation, that thereby they might the better know where to seek them, and being found how to express them.

*The Number of Constellations by the Ancients drawn upon the Celestial Globe was 48. viz.*

*In the Northern Hemisphere 21.*

First, *Ursa Minor*, *Helice Minor* & *Cynosura* in Latine ; In Arabick *Dub Alasgar*, that is to say, the *Lesser Bear* in English, and *Alrucaba* which signifieth a Waggon or Chariot ; by us call'd *Charles's Wain* made of Seven Stars, four for the Wheels and three for the Horses ; that of the Pole-Star being the fore-horse. That Star in the tip or end of the Tail is called the *Pole-Star*, because nearest to the Pole of any other ; and in the Year 1700 will be but 2 deg. 14 min. from the Pole, and will come nearer and nearer to the Pole for about 400 years, when it will be within half a degree of it, and then it will depart from it again for 12706 years together, till it comes to be within 42 deg. 42 min. of the Equinoctial, which will be in the void space between *Draco* and *Lyra* ; at which time *Lyra* will be almost as near the Pole, as the Pole-

Pole-star now is: And the last Star in the stalk of the *Dove's Mouth*, will be then very near the Southern Pole. The two bright Stars in the fore-part of the Body, the Arabians call *Alferkathan*, by our Seamen the *brightes of the Gaurds*.

2. The Second is, *Ursa Major*, *Caliste Magisto*, Lat. The *Great Bear*, English; *Dub Alacher*, in Arabick; by the Greeks *Ἀρκτοῦρος*, ἡ ἀρκτὸς ὅραμα. The first Star in the back of it is called *Dub*. *καστιόλιον*, and that which is in the flank is called *Miræ* or *Mizar* by *Scaliger*. The first in the Tail is called *Aliare*, and by *Scaliger*, *Aliath*. Both these *Bears* are by the Greeks called *ἀρκα*, which signifieth a Waggon or Chariot. But this name doth properly belong to those seven bright Stars in the Great Bear, by us called *Charles's Wain*, and by the Arabians *Beneth As*, or rather *Benesh asch*. And by imagining a Line to be extended by those two Stars in the *Bear's* Rump, you may find the Pole-star, and also the Pole, if you fancy the Pole-star, and the next to it to make an Equilateral Triangle, less than three degrees with the Pole, in a strait Line between *Aliath* and the Pole-star.

3. The Third is called *Draco*, & *Vrago*, Græc. *Δράκων*, Arab. *Alanin*, and *Ras Aben*; by *Scaliger* *Ras Taben*. Eng. *The Dragon*. It lies wreathing betwixt the *Two Bears*, and hath stars in every one of the 12 Signs: And the Pole of the Ecliptick lies in the midst of it.

4. The Fourth is *Cepheus*, a King of *Ethiopia*, in Arab. *Alredaf*; it hath one Star called *Alde-  
raimin*, which signifieth the right Arm. By the Phœnicians *Phicures*, that is *Flammiger*; by the Græc. *Πηλίκης*.

5. *Bootes*, Græc. *Bubulcus*, and *Arctophylax*, Lat. *Custos Erymanthydos Ursa*, Eng. *the Keeper of the Bear*, Arab. *Alhava*, that is *Vociferator*, and *Alfamech Alramech*, that is the *Lance bearer*. Betwixt the Legs of this Constellation stands a Star of the first Magnitude called by the Græc. and Lat. *Arcturus*, by the Arab. *Alramech* or *Somech Haramach*, by the Heb. called *Gnasch* or *Asch*, which signifies a Congregating, or gathering together.

6. The sixth Constellation is *Corona Borea*, & *Gnosia margarita*, the *Northern Crown*, or *Ariadnes Crown*. By the Arabians called *Aclilasche mali*, by the Greeks Στέφανος Βόρεα, whereof the brightest Star is called *Alphecca*, *id est Solutio*; by some called also *Munic*.

7. *Hercules*, or *Egonasi*, in Arab. *Alcheti hale rechabatch*, that is one falling upon his Knees, by the Greeks Εγγυσις ἑγνων. In Lat. *Ingeniculum*, *Geniculator*, *Genunixus*, *Saltator*, *Nisus*, or *Nixus*: That Star in the Head is called *Ras Alcheti*, or *Ras Algethi*; another in the Arm is called *Marfic*; and the last in the Arm is called *Mazem* or *Maasim*, which signifieth Strength.

8. Is the *Harp*, Lat. *Lyra* & *Vultur Cadens*; in Arab. *Scalias*, and *Alvakah*, that is *Cadens* Græc. Λυγὴ χάλυξ. The bright Star whereof is called *Lucida Lyra*, by *Alphonsus*, *Vega*.

9. Is *Cygnus*, or *Gallina*, *Olor*, *Milvius*, *Cyconia*, the *Hen*, or *Swan*; in Arab. *Aldigaga* and *Altayr*, viz. the *Flying Vultur*, in Græc. Κύνεος ὄρνις. One Star whereof is called in Arab. *Deneb Adigege*, the *Tail of the Hen*, and also *Arided*. In the year 1600. a New Star appear'd in the Breast of the *Swan*, of which *Kepler* writ a Tract, after it had continued in the same place 6 Years; being a Star about the third Magnitude.

10. Is

10. Is *Cassiopeia*, the Mother of *Andromeda* and Wife of *Cepheus*; in Arab. *Dhath Alcurfi*, the Lady in the Chair. In the year 1572. there appeared in *Cassiopeia* a new and great Star of the first Magnitude in *Novemb.* the 11th, which lasted 11 Months, of which *Tycho Brahe* writ a large Volume. And others that observed it most accurately could not perceive it had any Parallax at all, nor distinguish any difference betwixt its true and apparent place. One Star in this Asterism is called *Scheder* by *Alphonfus*, but by *Scaliger* *Sedir*, viz. a Breast.

11. *Perseus*, in Arab. *Chamil*, *Ras Algot*, viz. bearing the Head of *Medusa*, or *Caput Gorgonis*. That Star which is on the top of his left hand is called in Arab. *Ras Algot*, and in Hebrew *Rosib hassatan*, the Devil's Head. That which is the 7th in Number, is called by *Alfonfus* *Alchcemb* for *Alchenib*, by *Scaliger* *Algeneb*, which signifies a Side.

12. *Auriga*, the Wagoner; *Bellerophon*, *Erichthonius*, *Osilochus*, *Heniochus*, *Hippolytus*; in Greek *Ἡρίων*; in Arab. *Roha*, & *Memassich* *Alhanam*; The bright Star in the left Shoulder is called in Græc. *Ἀῖξ* *Capra*, & *Hircus*, & *Capella*, a Goat; in Arab. *Alhajok*, or rather, *Alatod* teste *Scaliger*. And the two which are in his left hand are called *Ἐπίχοι*. *Hadi*, & *Agni* the Kids, in Arab. *Sadateni*, or rather *Sadateni*.

13. *Serpentarius*, *Aquitenens*, & *Anguiger*, the Serpent Bearer; in Arab. *Alhava* & *Hajalangue*. In *October* the 6th. *Anno* 1605. there appeared a new Star in the foot of this Constellation, being about the third Magnitude, and disappeared in *February* the year following, of which *Kepler* also writ a Book; to which the more curious may have a recourse for further Satisfaction.

14. Is *Serpens*, *Anguilla*, & *Anguis*, & *Ochiuchi*; in Arab. *Alhafa*, Græc. ὄφις *Eγχαλυσ*.

15. *Sagitta*, & *Telum*, the *Arrow* or *Dart*; in Arab. *Alfesham* & *Istuse*, which *Grotius* thinks is derived from ὄφης.

16. *Aquila*, *Vultur Volans*, the *Eagle* or *Flying Grype*, or *Vulture* in Arab. *Altayr*, & *Alhaakkab*.

17. *Antinous*, or *Ganymedes*, so called by *Hadrian* the Emperour, in memory of his Minion called *Antinous*. I find it not mentioned in the *Ptolemean Tables*; so that anciently it was only so many unformed Stars belonging to the *Eagle*.

18. *Delphinus*, the *Dolphin*, & *Arionis Vektor*, Græc. δελφίς, Arab. *Aldelphin*.

19. *Equiculus*, the little or lesser *Horse*, *Caput Equi*, *Equisextio*, *Hinnulus* in Arab. *Kátaat Alfarras* in Græc. περίουχον ἵππου, as it were the fore-part of a *Horse* cut off.

20. *Pegasus*, *Equus Alatus*, *Equus Bellerophonis*, *Equus Volans*, & *Equus bornus*, the *Flying* or *Winged Horse*; in Arab. *Alfaras Alatham*; the *Star* on the right *Shoulder*, is called *Almenkeb*, by us *Markeb*, and also *Seat Alfaras*, & *Brachium Equi*; and that in the opening of his *Mouth*, is called in Arab. *Enif Alfaras*, the *Nose* of the *Horse*.

21. *Andromeda*, Ἀνδρομέδα, in Arab. *Almara Almasulfela*, viz. the *chained Woman*: That *Star* in the *Girdle* is of the *Second Magnitude*, and is called *Mirach* in Arabick: By *Scaliger Mizar*. And that in the *Southern Feet* is called *Alamac*, or rather *Almaac*, viz. *Sock* or *Buskin*.

22. *Triangulum*, the *Triangle*; in Arab. *Almutaleth*, & *Mutlathum*, viz. *Triplcity*.

23. *Coma Berenices*, *Cincinnus*, κόμη Βερενίκης & πλόκαμος. This *Asterism* was anciently belonging

ing to the Sign of *Leo*; But *Conon* the Mathematician in favour of *Ptolemy* and *Berenice*, would have it called *Berenice's Hair*.

*Of the 12 Signs or Constellations of the Zodiack, and first of the Northern Signs.*

- γ The First is *Aries*, the *Ram*; *Phryxium Vellus*, Græc. Κριός, in Arab. *Alhamel*. The most noted Star is that in his Ear of the third Magnitude, from which *Copernicus* accounted the Procession of the Equinoctial.
- ♉ The Second is *Taurus*, the *Bull*; *Vector Europa*, Arab. *Altor*, or *Ataur*. That Star in the Eye, was called by the Arab. *Aldebaran*, viz. a very bright Star, & *Hain Altor*, the Bulls Eye, by the Romans called *Palilicium*. Those 5 Stars in his forehead representing the Letter V. in Lat. called *Succula* or *Hyades*, by the Greeks Ὑάδες, or *Vades*. There are also a Company of Stars on the Back of the Bull by the Greeks called the *Pleiades*, *Atlantiades*, by the Lat. *Vergillie*, by the Arab. *Atauria*, by us the *Seven Stars*, or the *Brood Hen*.
- ♊ The Third is *Gemini*, the *Twins*; in Arab. *Algeuze*, *Castor* & *Pollux*, *Apollo* & *Hercules*, whence the Arabians or Chaldeans call it *Aphellar*, & *Abracaleus*, for *Aphellan*, & *Gracleus* teste *Scaliger*: That Star in the Head of *Pollux*, is called *Ras Algeuze*.
- The Fourth is *Cancer*, the *Crab*; in Arab. *Alsartan*: Three Stars in this Constellation, tho small, are not uncelebrated by the Poets, one in the Breast called *Presape*, in Arab. *Mellef*, the *Crib* or *Stall*; the other two are the *Asselli*, viz. *Alinus Australis* & *Borealis*.

9. The

♌ The Fifth is *Leo*, in Arab. *Alased* or *Alazet*, said to be the Lion which *Hercules* slew in the *Nemean* Wood ; It hath two Stars of the first Magnitude, the one called *Cor Leonis*, *Regulus*, βασιλικός Græc. *Kala Alased* & Calb. *Alazet*, the Heart of the Lion. The other in the Tail of the Lion is called *Deneb Alazet*, or *Alased* Arab. Lat. *Cauda Leonis* ; The Tail of the Lion, by *Alfraganus* is called *Asumpha*.

♍ The Sixth *Virgo*, the *Virgin* ; Arab. *Eladari*, *Virgilio*, *Aggino*, & *Erigon* ; by others, *Astræa* *Prævindemiatrix*, παρδίνθη, προαυχήκη, *Almacedir*, *Alarof*. *Aratus* calls her the Daughter of *Ascreus*, & *Aurora*, others tells us she was *Fortune*, or *Ceres*. Others say she was *Pantheon* the Daughter of *Apollo* : Of the Stars in this Asterisin, there is one in her right hand called by the Arabians *Sanbale* & *Hazime* Alhacel, which signifies an Ear, or handful of Corn ; in Græc. σαρξ, call'd also *Alcimon*, *alace Azimech*, *Vulgo Spica Virginis*, & *Arista Sacra*. ; The other in her Wing is called *Vindemiatrix* Ἀμπελος, a Gatherer of Grapes.

*Of the Constellations of the Southern Hemisphere, and first of those of the Zodiack.*

♎ The Seventh is *Libra*, *Jugum*, ζυγός χαλκί, th *Ballance*. Mr. *Hew*s tells us, that this Constellation was not anciently reckoned among the Signs ; till the later Astronomers robbing the *Scorpion* of her Claws, translated the same to *Libra*, and made up the Number of the Signs ; whence the Arabians call the North Ballance *Zubeneschi Mali*, in Greek χαλκή Βόρεια, the *North Claw* ; And the South Ballance *Zubenalge-nubi*,



*halge-nubi*  $\chi\lambda\acute{\iota}\nu$   $\text{N}\acute{\omicron}\tau\iota$   $\odot$ , the North Claw; or *Mizan Aliemin*, *Libra dextra*, The right hand or Southern Ballance.

☿ The Eighth is *Scorpio*, the Scorpion; Arab. *Alatrab* or *Alacrab*; that Star in the Breast is called *Kelebalacrab*, that is the Heart of the Scorpion; and that in the end of the Tail is called *Leschat*, or rather *Lefath*, which signifieth Sting of any Venemous Creature: It is also called, *Schomlek*, which *Scaliger* thinks, by Transposition of Letters, is read for *Mofclek*; which signifies the bending of the Tail.

♈ The Ninth is *Sagittarius*, *Semivir*, *Arctenens*, in Gr.  $\tau\omicron\acute{\alpha}\rho\chi\acute{\iota}\tau\eta\varsigma$ , the Archer; in Arab. *Elcufu*, or *Elcaufu*, which signifies a Bow.

♐ The Tenth is *Capricornus*, the Goat; in Arab. *Algecli*; That Star in the Tail is called *Deneb Algedi*, the Tail of the Goat.

♑ The Eleventh is *Aquarius*, *Ganymedes*, *Hyracoprotes*, the Waterman; in Arab. *Eldelis*, which signifieth a Bucket to draw Water in; in Gr.  $\iota\delta\epsilon\chi\acute{\alpha}\nu\omicron\varsigma$ : The Tenth Star of this Constellation in *dextra Tibia*, is called in Arab. *Sheat*, which signifieth an Arm; and that *Ultima in Effusione*, is called *Fomahant*.

♒ The Twelfth is *Pisces*, the Fishes, in Arab. *Alsemcha*; *Linum* or *Nodus*, is that which joyns the Fishes.

*Of the Constellations of the Southern Hemisphere, which are without the Zodiack.*

The First is *Cetus*, *Balena*, *Pistrix*, the Whale; in Arab. *Elkaitos*; One Star is called *Menkar*, by *Scaliger*, *Monkar Elkaitos*, the Nose or Snout of



the Whale: Another called *Boten-Elkaitors*, the Belly of the Whale: And a third, *Deneb Elkaitos*, the Tail of the Whale.

2. *Orion*, the Warriour; by the Greeks *Ὠρίων*, by the ancient *Romans*, *Jugula*; by the Arab. *Asugia*, & *Algibbar*: The first signifieth, a bold or furious Fellow; the latter, a strong Man or Giant. There is mention made of *Orion* in *Job*, chap. 9. ver. 9. ch. 38. v. 31. and in *Amos* 5. v. 8. where the Word in the Original is *Kesil*, which signifieth Madness, Rage, and Instability. When this Constellation riseth with the Sun, it causeth great store of tempestuous Weather in all Places; and answereth to the Arab. Word *Asugia*, whence stiled by the Poets, *Nimbosus*, & *Aquosus Orion*. That Star in his right Shoulder is called *Jed Algeuze*, or *Bed Elgeuze*; That in his left Shoulder is called *Bellatrix*, the Warriour; That in his left Foot is called *Rigel Algeuze*, or *Algibbar*. There are also Three Stars in his Girdle, called the *Ladies Wand*, or *Golden Yard*; and Three more in the Sword, vulgarly called, the *Ell*, directly pointing to the Girdle; both which are very remarkable.

3. *Eridanus*, *Nilus*, *Fluvius*, in Gr. *Ποταμός*; in Arab. *Alvabar*; that is, the River. The Nineteenth Star is commonly called in Arab. *Angetenar*, by *Scaliger* rather *Anchenetenar*, which signifies the Winding or Turning of a River: And the 29th is called, *Beemin*, or rather *Theemin*, which signifies any two joyned together: And the last Bright Star in the end of it, is called *Acharnahan*, that is, behind, or at the end of the River, and is commonly called *Acarnar*, or *Achernar*.

4. *Lepus*, the *Hare*; Arab. *Alernebet*, Gr. *Λαγώς*.

5. *Is*

5. *Is Canis Major*, the Great Dog; *Lelaps Alcheleb*, *Alachbar*, & *Alfahare*; & *Aliemalijsa*; Arab. that is, the right Hand, or Southern Dog: The name *Alfahare*, which is sometimes written *Scera*, *Scaliger* thinks it derived from an Arabick Word, which signifieth the same that *ῥαροσομία* in Greek; a Disease that Mad Dogs are troubled with all. *Grotius* doubts whether it should not rather be *Elseiri*, and so derived from the Greek Word *Σείρις*. That Star in the Mouth is called *Sirius*, in Arab. *Gabhor*, or *Ecbar*; the brightest Star in the Heavens.

6. *Canis Minor*, *Cunicula* & *Antecanis*, in Greek, *Πρόκυων*, Arab. *Alcheleb Alasgar*; that is the Lesser Dog. Also *Alfahare-alfemalijsa*, and corruptly *Algomeiza*, the Left Hand, or Northern Dog.

7. *Argo Navis*, the Ship; Greek *Ἀργώ*, Arab. *Alsephina*, or *Sephina*, called also *Markeb*, which signifieth a Chariot, in Gr. *Ἀρμα θαλάσσης*, a Sea Chariot. It has one Star of the first Magnitude, called *Canopus*, in Arab. *Sohel*, or *Syhel*, by the Gr. *Κανόψ*, by the Heb. *Chesil*, teste *Christamanus*; but *Arius Montanus* makes *Orion* to be *Chesil*.

8. *Hydra*, or *Hydrus*, in Arab. *Alfugath*, or *Afuja*, which signifieth strong or furious. The Egyptians call'd it *Nilus*, teste *Theon*, in his Comment upon *Aratus*. That star in its Heart is called *Alphart*, by us, *Cor Hydra*.

9. *Crater*, the Cup; in Arab. *Albatina* & *Elkie*, which signifies a Goblet, or standing Cup.

10. *Corvus*, the Crow, *Algorab*, Arab.

11. *Centaurus*, the Centaur, called also *Typhon* and *Chiron*, in Gr. *Χείρων*. In the hinder Feet of this Constellation, are a company of Stars, which in regard they appear to the Mariners in form of a Cross, are called the *Crossiers*. Near this Con-

stellation there are several unformed Stars, which in the year 1679. Mr. *Edmund Halley*, in memory of *Charles II.* King of *Great Britain*, &c. who was preserved by his Hiding in an Oak, reduced them into a Constellation, and called it *Robur Carolinum*.

12. *Fera*, the *Wild Beast*, call'd, in Arab. *Asida*, signifying a Lioness; and *Alsubahh*, that is, a Wolf, or other ravenous Beast.

13. *Ara*, or *Thuribulum*, the Altar or Censer, in Arab. *Almugamra*.

14. *Corona Australis*, the Southern Crown, in Arab. *Alachil Algenubi*.

15. *Piscis Austrinus*, the Southern Fish, in Arab. *Ahaut Algenubi*: The bright Star in his Mouth, is called *Phom Ahut*; that is, the Mouth of the Fish, now called *Fomahant*.

There are yet upon our new Globes depicted Twelve Constellations more, posited about the South Pole, which were first added by *Frederick Houtman*, inhabiting on the Island *Sumatra*; who observed the Longitude and Latitude of those Stars, and reduced them into Constellations, and named them as follows:

The 1. *Grus*, the Crane; 2. *Phoenix*; 3. *Pavo*, the Peacock; 4. *Indus*, the Indian with a Dart in his hand; 5. *Toucan*, the American Goose, or *Brazilian Pie*; 6. *Dorado*, the Golden Fish, or, Gilt-head Fish; 7. *Piscis Volans*, the Flying Fish; 8. *Hydrus*, the Southern Serpent; 9. The Camelion; 10. The Fly; 11. *Avis Indica*, the Bird of Paradise; 12. *Triangulum*, the South Triangle. There are also Two other Signs added to the former Southern Constellations, viz. *Noah's Dove*, and



and the *Phœnicopter*, or *Bittour* ; by the *Spaniards*, *Flamengo*. These were since observ'd and rectified by the Ingenious *Mr. Halley*.

*There be Three several Reasons which induced the Ancients to bring the Stars into these Shapes.*

First, These Figures express some Property of the Stars ; as those of the *Ramm* to be hot and dry, for so is the *Ramm*. *Andromeda* chained, betokeneth Imprisonment ; The Head of *Medusa* cut off, signifies the loss of that Member. *Orion*, with his terrible and threatening Gesture, importeth Tempest, and terrible Weather. The *Serpent*, the *Scorpion*, and the *Dragon*, signifie Poison. The *Bull* insinuateth a Melancholy Passion. The *Bear* inferreth Cruelty, &c.

Secondly, Some of the Stars, if not precisely yet after a certain sort do represent such a Figure ; and therefore such a Figure was assigned them : As for example, The Crown both N. and S. The *Scorpion* and the *Triangle*, partly represent the Figures which they have.

Thirdly, It was for continuance of the Memory of some notable Men, who either in Regard of some worthy Deeds had well deserved of Mankind ; as *Hercules*, *Persens*, &c.

Who was the first Author of these Constellations is uncertain ; we received them from *Ptolemy*, and he received them of the *Platonicks* ; so that their Antiquity is great. *Thyestes* the Brother of *Atreus*, is said to have invented the Constellation of the *Ramm*. In the 38th Chapter of *Job*, there is mention made of the *Pleiades*, *Orion*, *Arcturus* and *Mazzaroth*, which some in-

terpret the 12 Signs. *Job* lived in the time of *Abraham*, as *Siderocrates* maketh mention in his Book, *De commensurandis Locorum Distantiis*.

*Of the Via Lactea, or Milky Way.*

This is a broad white Circle that is seen in the Heavens, and is described between two Tracts of small pricks, running through several Constellations round the Globe. It is caused by a great Number of little Stars constipated in that Part of Heaven so small and thick, that we can perceive nothing but a confused Light. About the Southern Pole are also discovered two white Spots, seeming to be only two white Clouds, being a pale Assembly of very small Stars, as in the *Galaxy* or *Milky Way*; which are more clearly discovered by the Telescope, otherwise inconspicuous to our Eyes.

*Stella Nebulosa* is nothing but a Congeries of small Stars, as the *Nebulosa* of *Orion's Head* hath 21 small Stars: That of the *Manger* call'd *Præsepe* in the *Crab*, consist of more than 40, &c.

All the Stars are found increased or increasing in Longitude about  $51' 48''$  per *Ann.* and make a Revolution in about 2700 years, which is caused by the Precession of the Equinox, from which their Longitude was wont to be reckoned, and not by any Motion of their own: yet many, if not most of the small Stars, are found to move, somewhat change Scituation and Magnitude; nay, some to have their Revolutions of Appearing and Disappearing in exact spaces of time; as one in the Breast of the *Swan* hath a Revolution of about 20 years; Another in the *Whale's Neck*, which appears sometimes of the third Magnitude,  
The

The Period of whose Revolution from its greatest appearance to its least, is about 333 days; but the time from the first Moment of its appearing first of the sixth Magnitude, to the day it comes again to the same Magnitude is about 120 days; and the time of its duration at its greatest Magnitude is about 15 days. Another in *Andromeda's Girdle*. And another about the *Swan's Head*, viz. a little beneath it, among the Unformed, whose Longitude is  $1^{\circ}, 52', 26''$  and Latitude  $47^{\circ}, 25', 22''$  North, which finisheth its Revolution visible, invisible, increasing and decreasing as that in the Neck of the *Whale*; only that makes its Revolution in 11 Months, this in 10; also this riseth to its greatest Splendor, viz. to that of the third Magnitude, and falls from its and rise again to it in one Month's time; which is a very strange Phenomenon.

There are missing two Stars of the second Magnitude in the Poop of the *Ship*, and near the *Great Dog*, which after the year 1668. were not to be seen. Above 100 Stars are found thus Moveable by accurate Observations, which have been mostly made of them since 1664. which makes some alter their Opinion, That new Stars, or Stars new appearing, are the weaker intention of Nature, and when they disappear they suffer a Dissolution. A little time more will manifest more of this, *Et videbitis Cælum apertum.*

*Of the Planets.*

The wandring Stars or Planets which are in number Seven, viz. *Saturn, Jupiter, Mars, Sol, Venus, Mercury,* and the *Moon*: They are easily known from the fixt Stars, the Sun and Moon, by their great and



visible Light ; *Saturn* for that he is of a dull Lead-  
 den Colour ; *Jupiter*, because of his Splendidness  
 and Azure Colour, being a large and bright Star ;  
*Mars*, because of his Red and Fiery Appearance ;  
*Venus*, by reason of her great and bright Body,  
 appearing bigger than any Star in the Firma-  
 ment : And further observe, that she is always  
 seen a little before Sun-rising, or else presently  
 after his Setting ; from whence she obtains the  
 name of *Morning* or *Evening Star* ; As for *Mer-  
 cury* he is seldom to be seen, by reason he is so  
 small and follows the Sun so close, that his Body  
 is wholly obscured, unless at the very time of his  
 greatest Elongation from him ; The Planets are  
 also known from the fix'd Stars by their not  
 Twinkling. As for all the Planets (except  
 the *Sun*, who is always found in the Ecliptick)  
 they very often shift and change their places (the  
 Superior, viz. *Saturn*, *Jupiter*, and *Mars*, not so  
 often as the Inferior, viz. *Venus*, *Mercury*, and  
 the *Moon*) being sometimes found on the North-  
 side of the Ecliptick, at others upon it, and  
 sometimes on the South-side thereof ; by reason  
 of which Alteration, they are never incerted on  
 an Artificial Globe, only their Characters are  
 sometimes figured on the Horizon, and are as  
 follows :

*Saturn* ♄, *Jupiter* ♃, *Mars* ♂, *Sol* ☉, *Venus* ♀,  
*Mercury* ☿, the *Moon* ☾ ; also the *Earth* ⊕.

Having thus given you a brief Account of the  
 several *Hypotheses*, and of the Explanations of the  
 Lines, Circles, &c. of the Globe or Sphere, it  
 will be convenient now to shew you the Uses  
 thereof, in the Solution of Problems of divers  
 Kinds : in the performance whereof, I shall be  
 both brief and plain. And

And whereas I formerly said, that divers Problems may be resolved upon either Globe, it being in any position whatsoever (which will plainly appear hereafter) yet it will be more convenient to have the Globe fitted and accommodated with all its necessary Appendants before you make use of it. And therefore my first business shall be, to shew how to fix and set the parts of the Globe together, fit for use in any assigned Latitude or Part of the World : and this I call *Rectifying of the Globe.*

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*How to Rectifie the GLOBES, fitting them for Use in any Latitude or Place of the World.*

**B**Eing provided of a pair of Globes, the Meridian, Horizon and Hour-circle truly turned and divided ; also the Ball truly hung, and the Meridian and Horizon (in all Positions) cutting each other at Right Angles, the Papers truly joyned in their Pasting, &c. you may proceed to Rectifie them in this manner.

1. Put the Brass-Meridian into the two Notches that are in the North and South-parts of the Horizon ; the Graduated or divided part thereof towards the East-point, and the blank or plain side of the Meridian towards the West-point of the Horizon ; and let the Meridian rest in the Notch which is in the foot or bottom of the Horizon.

2. Place



2. Place the Hour-circle about the Pole, so that the Hour-lines of 12 and 12, do lie directly over the East or Graduated side of the Meridian, and that the point of the Axis do pass directly through the Centre of the Hour-circle; so shall the two Twelves, one of them represent 12 at Noon, and the other 12 at Midnight; and the two Sixes, the one 6 in the Morning, and the other 6 at Night. Then put the little Index or Pointer upon the Axis, so that it may move as you turn the Globe about, and so is your Hour-circle Rectified.

4. Elevate the Pole of your Globe (whether the North or South-pole) according to the Latitude of that part of the world you are in: as for Example, for *London*, whose Latitude is 51 deg. 30 min. North; (the Meridian being in the Notches of the Horizon, and also in that in the foot of the Frame, as is before directed,) Move the Meridian up or down in the Notches, till you find 51 deg. 30. min. of the Meridian to touch the upper plane of the North-part of the Horizon: for then is your Globe set to the Latitude of 51 deg. 30 min.

5. For the Rectifying of the Quadrant of Altitude, this also must have respect to the Latitude: Wherefore, the Latitude being 51 deg. 30 min. count 51 deg. 30 min. upon the South-part of the Meridian, from the Equinoctial-circle towards the North (or elevated) Pole; and put on the Nut which is at the end of the Quadrant, so that the edge of the divisions of the Quadrant may lie directly under the degrees of the Latitude,

tude, viz. under 51 deg. 30 min. And then screw the Nut fast ; and so is the Quadrant of Altitude rectified also.

These are the four principal things that almost in all Cases must be rectified : for the Circle of Position, that seldom comes in use but in *Dialling and Astrology*, and therefore it is not usually Made or Sold with the Globes ; but when there is occasion for it, you must rectifie it as followeth.

6. The two ends of the Diameter of this Circle are to be placed in the North and South-points of the Horizon ; and it is to move up and down between the Meridian and the Horizon, and there to be fixed or held at any acquired place.

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## *Astronomical Problems.*

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### P R O B. I.

*The day of the Month known, either according to the Julian or Gregorian Account, to find the Sun's place in the Ecliptick.*

**S**EEK the Day of the Month ( in either Account ) according as you find them placed in the Kalendar, and right against it, in the innermost Circle next to it, you shall have the Degree and Minute in which the *Sun* shall be that Day at Noon.

### E X A M P L E.

Let the Day proposed be the 18th of *October*, (in the *Julian*, or the 28th of *October* in the *Gregorian Account*) which is *St. Luke's Day* : Find this Month and Day in the Kalendar, and right against it (in the innermost Circle) you shall find 5 Deg. 32 Min. of *Scorpio*, in which Sign and Degree the *Sun* will be upon that 18th or 28th of *October*.

In like manner, upon the 24th of *April*, (*Julian*) or the 4th of *May*, (*Gregorian*,) (which is all one day) the *Sun* will be found to be in 14 Deg. 32 Min. of *Taurus*. And so of any other Day,

Day, as in the following Table, which sheweth, that upon

	Jul.	Greg.		deg. m.	
January	7	17		28 9	Capricornus ♑
February	12	22		4 38	Pisces ♓
March	23	Apr. 3	The Sun's place at Noon will be in	13 23	Aries ♈
May	16	26		5 39	Gemini ♊
July	27	Aug. 7		14 16	Leo ♌
September	3	13		21 0	Virgo ♍
November	5	15		23 41	Scorpio ♏

P R O B. II.

*By knowing the Place of the Sun in the Ecliptick, the Day of the Month in either of the Accounts may be obtained: As followeth.*

**S**EEK the Sign, Degree and Minute in which the Sun is, in the innermost Circle of the Horizon; and right against it, you shall have the Day of the Month in both Accounts.

E X A M P L E.

Let the Sun be in 24 Deg. of Gemini; look in the innermost Circle for the Sign Gemini, and against it in the Kalendar you shall find the 4th of June, (Julian,) or the 14th of June, (Gregorian,) which is the Day of the Month.

In like manner, when the Sun is in 14 Deg. 53 Min. of Capricorn, the Day of the Month will be found the 25th of December, (Julian,) or the 4th of January, (Gregorian.)

P R O B.

## P R O B. III.

The Latitude (51 Deg. 30 Min.) and the Sun's place in the Ecliptick (*viz.*) in 29 deg. of *Taurus* being given, to find

*The Sun's Declination.*

Defini-**T**he Sun's Declination is an Arch of the tion.] Meridian, comprehended between the Equinoctial Circle, and that point of the Ecliptick in which the Sun is.

Practice.] Bring the 29 Deg. of *Taurus* to the Brass-Meridian; then shall the Degrees of the Meridian contained between the Equinoctial and this point, be 20. So that the Declination of the Sun is 20 Deg. North, because the Sun is in a Northern Sign.

In like manner,

	deg. min.		deg. min.
When	{ 16 00 $\gamma$	The Sun's Declination will be found to be	{ 6 00 North.
the Sun	{ 25 00 $\pi$		{ 19 00 South.
is in deg	{ 29 00 $\approx$		{ 12 30 South.
	{ 13 00 $\Omega$		{ 16 50 North.

## P R O B. IV.

*The Sun's Amplitude.*

Defini-**T**he Amplitude, is an Arch of the Hori- tion.] zon comprehended between the East or West-points thereof, and that point upon which the Sun doth Rise or Set.

Practice.]

*Practice.*] Bring 29 Deg. of *Taurus* to the Horizon, and there you shall find 33 Deg. 20 Min. to be contained between that, and the East or West-point, towards the North, because the *Sun* is in a Northern Sign, that is very near the North-East by East Point of the Compass, as appears by the Points upon the Horizon: and that is the Amplitude.

And in like manner,

	deg. min.		deg. min.
When	16 00 ♈	The <i>Sun's</i> Am-	26 00 North.
the <i>Sun</i>	25 00 ♎	plitude will be	30 30 South.
is in	29 00 ♊	from the East	17 30 South.
deg.	13 00 ♍	or West found	9 30 North.

P R O B. V.

*The Sun's Right Ascension.*

**Defini-** **T** *He Right Ascension of the Sun, or of a Star, is that Arch of the Equinoctial which is contained between the beginning of Aries, and that point of the Equinoctial which comes to the Meridian, with that point of the Ecliptick in which the Sun or Star is.*

*Practice.*] Bring the 29 Deg. of *Taurus* to the Meridian; so shall you find (upon the Equinoctial) 56 Deg. 50 Min. to be contained between the beginning of *Aries* and the Meridian: And such is the *Sun's* Right Ascension when he is in the 29 Deg. of *Taurus*.



In like manner,

	deg. min.		deg. min.
When the <i>Sun</i> is in deg.	16 00 ♈	The <i>Sun's</i> Right Af- cension will be	138 26
	25 00 ♉		232 38
	29 03 ♊		329 30
	13 06 ♋		12 34

# PROB. VI.

## The Oblique Ascension.

**Defini-** **T**He Oblique Ascension of the Sun, or of a  
tion.] Star, is that Arch of the Equinoctial  
which is comprehended between the beginning of Aries  
and that point of the Equinoctial which comes to the  
East-point of the Horizon, with that point of the E-  
cliptick in which the Sun or Star is.

**Practice.]** Bring 25 Degr. of *Taurus* to the East-  
side or Semicircle of the Horizon, then shall you  
find 29 Deg. of the Equinoctial to be contained  
between the beginning of *Aries* and the East-  
point of the Horizon; and that is the Oblique  
Ascension of the *Sun* or Star, it being in the 29  
Degree of *Taurus*.

In the same manner,

	deg. min.		deg. min.
The <i>Sun</i> being in	16 00 ♈	The Oblique Af- cension will be found to be	117 10
	25 00 ♉		258 27
	29 00 ♊		345 30
	13 00 ♋		006 06

# PROB.

## P R O B. VII.

*To find the Ascensional Difference.*

Definition.] **T**He Difference of Ascension, is no other than the Difference of Degrees, between the Right and Oblique Ascension. Wherefore, subtract the lesser from the greater, and the remainder will be the Ascensional Difference; which will be found to be 17 Deg. 14 Min. Or, The Ascensional Difference, is that space of time contained between 6 of the Clock, either in the Morning or the Evening, and the time of the Sun's Rising or Setting. Wherefore,

## P R O B. VIII.

*To find the time of the Sun's Rising and Setting.*

Practice.] **B**Ring 29 Deg. of *Taurus* to the Meridian, and set the Index of the Hour-wheel to 12 of the Clock Southward: Then turn the Body of the Globe Eastward, till 29 Deg. of *Taurus* touch the East-side of the Horizon; and then will the Index of the Hour-wheel point out 11 Min. after 4 in the Morning, at which time the *Sun* Riseth. And if you turn the Body of the Globe about Westward, till the 29 Deg. of *Taurus* doth touch the West-side of the Horizon, then shall the Index of the Hour-circle point at 49 Min. after 7 at Night, at which time the *Sun* setteth.

## P R O B. IX.

*To find the Length of the Day and Night.*

*Practice.* **T**urn the Globe about, till 29 Deg. of *Taurus* touch the East-side of the Horizon; and then set the Index of the Hour-Circle to the North (or undermost) 12. Then turn the Globe Westward, till 29 Deg. of *Taurus* touch the Horizon on the West-side; and then shall the Index of the Hour-wheel point at 3 H. 38 Min. more than 12 Hours. So that the day is then 15 Hours and 38 Min. long. And if you count the Hours between the North 12, and the Hour-Index, you shall find them to be 8 H. and 22 Min. which is the length of the Night, the *Sun* being in 29 Deg. of *Taurus*.

And so,

		<i>Ascens.</i>		<i>Sun's</i>	<i>Sun's</i>	<i>length</i>	<i>length</i>
		<i>diff.</i>		<i>rise.</i>	<i>set.</i>	<i>of day.</i>	<i>of night</i>
d. m.		d. m.	h. m.	h. m.	h. m.	h. m.	d. m.
being in ☉	16 00 ♈	you'll find	21 12	4 35	7 25	14 50	9 12
	25 00 ♎		25 52	7 43	4 17	8 34	15 28
	29 00 ♏		15 00	7 00	5 00	10 00	14 00
	13 00 ♐		6 30	5 34	6 26	12 52	11 8

## P R O B. X.

*The Sun's Meridian-Altitude, and his Depression at Midnight.*

**T**his may be effected, by adding or subtracting of the *Sun's* Declination, to or from the Complement of the Latitude: For,

*Definition.*] It is an Arch of the Meridian, comprehended between the Intersection of the Meridian with

## Astronomical Problems.

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*with the Horizon, and that part of the Meridian upon which the Sun is at Noon or Midnight.*

*Practice.*] Turn the Globe about, till the 29 Deg. of *Taurus* be just under the Meridian; then shall you find the number of Degrees of the Meridian, which are comprehended between that point and the Horizon, to be 38 Deg. 30 Min. which is the Meridian Altitude. And if you bring the 29 Deg. of *Taurus*, to the opposite point of the Meridian under the Horizon, the number of the Degrees of the Meridian between that point and the upper Edge of the Horizon will be found to be 18 Deg. 30 Min. which is the *Sun's* Depression at Midnight.

In like manner,

	deg. min.		deg. min.		d. m.
When the Sun is in	16 00 ♈	You shall find the Meridian Altitude	54 36	and the de- pres.	22 24
	25 00 ♎		19 25		57 25
	29 00 ♊		26 00		50 22
	13 00 ♍		43 00		33 21

## P R O B. XI.

*When the Twilight begins and ends.*

*Definition.*] **T**He Twilight beginneth, when the Sun is 18 Deg. below the Horizon before its Rising; and it endeth, when the Sun comes to be 18 Deg. below the Horizon after its Setting.

*Practice.*] The Globe Rectify'd, and the Sun in 29 Deg. of *Taurus*, find the opposite point thereunto, which is the 29 Deg. of *Scorpio*, and bring that point, as also the Quadrant of Altitude, both

of them on the West-side of the Meridian; and then move both the body of the Globe, and the Quadrant of Altitude also, till the 29 Deg. of *Scorpio*, lie directly under 18 Deg. of the Quadrant of Altitude: Which done, keep them both together, and then see how many Hours the Index is removed from 12; which you shall find to be 1 Hour and 8 Min. So that *Twilight* begins at 8 Min. after 1 in the Morning. And this being taken from 4 Hours 11 Min. the time of the *Sun's* Rising that Day, there will remain 3 Hours 3 Min. which is the length or continuance of the *Twilight*. Also, if you double the time of the beginning of *Twilight* 1 Hours 8 Min. you shall have the length of dark Night, which will be but 2 Hours 16 Min.

In like manner, if you would know when the *Twilight* endeth after *Sun* setting, you must bring the 29 Deg. of *Scorpio*, (the point opposite to the *Sun*) on the East-side of the Meridian, making it and 18 Deg. of the Quadrant of Altitude; to meet; then the Index will shew 10 Hours 52 Min. and till that time of Night doth *Twilight* continue.

And so,

	deg.			h. min.			h. min.	
The <i>Sun</i> in	29 6	} day-break will be at	}	0 10	} aft. midn.	Twi- light last till	11 50	} at night.
	8 7			5 52			6 8	
	2 12			4 6			7 54	
	0 8			2 41			9 19	

And if you go about to find the time of the beginning and end of *Twilight*; all the time that the *Sun* is passing from 2 Deg. of *Gemini* to 30 Deg.

Deg. of *Cancer*, which is from about the 12th of *May*, to the 12th of *July*, you shall find that there will be no *Twilight* at all, but all that time continual day : for all that space of time, the *Sun* never descendeth so much as 18 Deg. under the *Horizon*, in the Latitude of 51 Deg. 30 Min.

P R O B. XII.

*What Altitude the Sun shall have, at 6 of the Clock in the Morning or Evening.*

**Defini-<sup>n</sup>** **T** *He Altitude of the Sun, or of a Star, &c. tion.] is an Arch of an Azimuth or Vertical Circle, passing through the Zenith and Nadir Points and the body of the Sun or Star, counted from the Horizon to the Sun or Star : And all such Azimuths or Vertical Circles, are represented by the Quadrant of Altitude.*

**Note,** That this Problem is only in use, when the *Sun* is in the 6 Northern Signs : For the *Sun* is never above the *Horizon* at 6, when he is in Southern Signs.

**Practice.]** Bring the 29 Deg. of *Taurus* to the Meridian, and set the Index of the Hour-circle to 12 ; then turn the Globe about Eastward, till the Index of the Hour-Circle come just to 6 a Clock : Then holding the Globe there, lay the Quadrant of Altitude just over the 29 Deg. of *Taurus*, and there you shall find it to cut 15 Deg. 30 Min. of the Quadrant. And such *Altitude* shall the *Sun* have at 6 of the Clock in the Morning, and the same at 6 at Night.



And so,

	deg. min.		deg. m.			
When the	{	16 00 $\Omega$	{	The Sun's Alti-	{	12 32
<i>Sun</i> is in		13 00 $\gamma$		tude at 6 will be		4 2
				found to be		

P R O B. XIII.

*What Azimuth the Sun shall have at six of the Clock.*

**Defini-** **T** *He Azimuth is an Arch of the Horizon,*  
**tion.]** *comprehended between the East, West,*  
*'North or South points thereof, and the intersection of*  
*a Vertical Circle, passing through the Sun or Star whose*  
*Azimuth you seek.*

¶ *Note, This Problem is of Use only when the Sun is in Northern Signs.*

*Practice.]* Bring the 29 Deg. of *Taurus* to the Meridian, and set the Index of the Hour-wheel to 12; then move the Globe till the Index lie upon 6; and holding the Globe there, lay the Quadrant of Altitude just over 29 Deg. of *Taurus*: Then shall you find, that there are 77 Deg. 14 Min. of the Horizon, contained between the Intersection of the North-part of the Meridian, and the Quadrant of Altitude, which is the Azimuth from the North: Or 12 Deg. 46 Min. from the East, which is the Azimuth from the East, or 102 Deg. 46 Min. from the South, which is its Azimuth therefrom.

In

In like manner,

	deg. min.		d. m.	d. m.	d. m.
<i>Sun in</i>		The <i>Sun's</i> A-	<i>North</i>	<i>E. or W.</i>	<i>South,</i>
$\left\{ \begin{array}{l} 16 \ 00 \ \Omega \\ 13 \ 00 \ \gamma \end{array} \right\}$		zimuth at	$\left\{ \begin{array}{l} 79 \ 49 \\ 86 \ 47 \end{array} \right\}$	$\left\{ \begin{array}{l} 10 \ 11 \\ 3 \ 13 \end{array} \right\}$	$\left\{ \begin{array}{l} 100 \ 11 \\ 93 \ 13 \end{array} \right\}$
		6 will be			
		found to be			
		from the			

P R O B. XIV.

*At what Hour the Sun shall be upon the East or West Azimuths.*

¶ This Problem is only of use when the *Sun* is in Northern Sigus.

*Practice.*] **B**Ring the 39 Deg. of *Taurus* to the Meridian, and the Index to 12 of the Clock. Also bring the beginning of the Degrees of the Quadrant of Altitude, to the East-point of the Horizon, and turn the Globe about, till the 29 Deg. of *Taurus*, do touch the Degrees of the Quadrant of Altitude; then shall the Index point at 7 Minutes past 7, at which time in the Morning, will the *Sun* be exactly upon the East Azimuth, or point of the Compass. And if you carry the Quadrant of Altitude to the West-point of the Horizon, and turn the Globe about till 29 Deg. of *Taurus* touch the edge of Degrees thereof, the Hour-Index will point at 4 of the Clock and 53 Minutes, at which time in the Afternoon, will the *Sun* be upon the West-Azimuth, or point of the Compass.

In the same manner,

	deg. min.		d. m.		d. m.
When the Sun is in	$\left. \begin{array}{l} 16^{\circ} 00' \Omega \\ 13^{\circ} 00' \gamma \end{array} \right\}$	It will be Due-	$\left. \begin{array}{l} 6^{\circ} 57' \\ 6^{\circ} 17' \end{array} \right\}$	West at	$\left. \begin{array}{l} 5^{\circ} 03' \\ 5^{\circ} 43' \end{array} \right\}$
		East at			

P R O B. XV.

*What Altitude the Sun shall have when he is upon the East or West-Azimuths.*

¶ This Problem is in use only when the Sun is in Northern Signs.

*Practice,*] **B**Ring 29 Deg. of *Taurus* to the Meridian, and the Quadrant of Altitude to the East or West-points of the Horizon: Then turn the Globe about, till the 29 Deg. of *Taurus* touch the Quadrant of Altitude, and you shall find it to touch at 25 Deg. 55 Min. of the Quadrant: And such Altitude hath the Sun, when he is upon the East or West-Azimuth.

In like manner,

	deg. m.		d. m.
When the Sun is in	$\left. \begin{array}{l} 16^{\circ} 00' \Omega \\ 13^{\circ} 00' \gamma \end{array} \right\}$	Its Altitude when East or West will be found	$\left. \begin{array}{l} 20^{\circ} 19' \\ 6^{\circ} 36' \end{array} \right\}$

P R O B.

## P R O B. XVI.

*What Altitude the Sun shall have at any time of the day.*

*Practice.*] **B**Ring 29 Deg. of *Taurus* to the Meridian, and set the Hour-Index to 12 a Clock. Then turn about the Globe, till the Hour-Index point to the given Hour (suppose 9 in the Morning, or 3 in the Afternoon :) there keep the Globe; and laying the Quadrant of Altitude over the 29 Deg. of *Taurus*, you shall find 43 Deg. cut thereby; and such Altitude shall the *Sun* have at 9 in the Morning, or 3 in the Afternoon. And by this Problem, the *Sun's* Altitudes in any Sign or Degree of the Ecliptick at all Hours may be found; as in this following *Synopsis* or Table, shewing what Altitude the *Sun* shall have at every Hour of the Day, in the beginning of every of the 12 Signs of the Ecliptick.

So the <i>Sun</i> being in the beginning of		<i>Cancer</i>	<i>Gemi.</i> or <i>Leo.</i>	<i>Taur.</i> or <i>Virgo.</i>	<i>Aries</i> or <i>Libra.</i>	<i>Scorp.</i> or <i>Pisces</i>	<i>Aqua.</i> or <i>Sagit.</i>	<i>Capri.</i>
At the ho.		d. m.	d. m.	d. m.	d. m.	d. m.	d. m.	d. m.
XII.	His Altitude will be	62 00	58 42	50 00	38 30	27 1	18 18	15 00
XI. I.		59 43	56 34	48 12	36 58	25 40	17 6	13 52
X. II.		53 45	50 55	43 12	32 37	21 51	13 38	10 30
IX. III.		45 42	43 0	46 0	26 7	15 58	8 12	5 26
VIII. IV.		36 41	34 13	27 31	18 8	8 33	1 15	
VII. V.		27 17	24 56	18 18	9 17	0 6		
VI.		18 11	15 40	9 0				
V. VII.	His Altitude will be	9 32	6 50					
IV. VIII.]		1 32						

P R O B.

## P R O B. XVII.

*What Altitude the Sun shall have, he being upon any Azimuth.*

*Practise.*] **S**ET the Quadrant of *Altitude*, to the *Azimuth* you intend to find the *Altitude* upon; (suppose the 30 Deg. of *Azimuth* from the South towards the East :) bring the Quadrant of *Altitude* thither; and keeping of it there, turn the Globe about, till 29 Deg. of *Taurus* touch the Degrees of the Quadrant of *Altitude*, and you shall find them to concur at 55 Deg. 34 Min. of the Quadrant: And such is the *Sun's Altitude*, when he is 30 Deg. from the South-part of the Meridian, either Eastward or Westward. And by this means you may find the *Azimuth* at all times. An Example of the *Sun's Altitude* upon every Tenth *Azimuth* from the South, in the beginning of each Sign, here followeth.

**A T A B L E** shewing what *Altitude* the *Sun* shall have, he being upon every *Tenth* *Azimuth* from the *South* in the beginning of each of the *XII* *Signs*.

The <i>Sun</i> in the beginning of		Cancer		Leo or Gemi.	Virgo or Taur.	Libra or Aries.	Scorpio or Pisces.	Sagitt. or Aqua.	Capri.
d. Ar.		d. m.	d. m.	d. m.	d. m.	d. m.	d. m.	d. m.	d. m.
Its Altitude on these Degrees of Azimuth from the South, viz.	0	62 0	58 42	50 0	38 30	27 0	28 18	15 0	
	10	51 43	58 24	49 38	38 4	25 30	17 45	14 25	
	20	40 51	57 28	48 33	36 46	25 10	16 5	12 41	
	30	39 52	55 52	46 40	34 34	22 27	13 15	9 45	
	40	37 20	53 29	43 51	31 21	18 48	9 14	5 34	
	50	34 3	50 12	40 11	27 5	13 58	3 57	0 6	
	60	49 56	45 53	35 23	21 41	8 0			
	70	44 40	40 25	29 27	15 13	1 0			
	80	28 11	33 46	21 29	7 52				
	90	30 38	26 10	14 25					
	100	22 27	18 2	6 45					
	110	14 14	9 58						
	120	6 34	2 30						

These Tables are of good Use for the making of *Cylinders*, *Quadrants*, and other Instruments that give the *Hour* and *Azimuth* by the height of the *Sun*, and also to insert the *Tropicks* and other *Signs* of the *Zodiack*, and *Azimuths*, into *Sun-Dials*, &c.

The



The Latitude (51 Deg. 30 Min.) the Sun's place in the Ecliptick, (29 Deg. 0 Min. of Taurus) and his Altitude (12 Deg.) being given : To find the Sun's Azimuth and Hour.

P R O B. XVIII.

To find the Sun's Azimuth at any time.

*Practice.*] **T**HE Globe being Rectified, &c. and the Quadrant of Altitude fixed, and brought to the Horizon ; Turn 29 Deg. of Taurus toward the East, if in the Morning ; or towards the West, if in the Evening, till it come to lie just under 12 Deg. of the Quadrant of Altitude ; and then Note, at what Degree in the Horizon the Quadrant of Altitude resteth ; which will be at 17 Deg. 8 Min. from the East if in the Morning, or 17 Deg. 8 Min. from the West if in the Afternoon Northward, which is the *Azimuth*, from the East or West, towards the North. And this *Azimuth*, if reckoned by the Points of the Compass upon the Horizon, will be E. by N. 5 Deg. 53 Min. Northward, if in the Morning ; or W. by N. 5 Deg. 53 Min. Northward, if in the Evening, when the Sun is in 29 Deg. of Taurus, and hath 12 Deg. of Altitude. Now if you count the Degrees of the Horizon, between the Quadrant of Altitude and the North-part of the Meridian, you shall find them to be 72 Deg. 52 Min. which is the *Azimuth* from the North : And if you count them from the South-part of the Meridian, you shall find them to be 107 Deg. 8 Min. which is the *Azimuth* from the South.

In

In like manner,

	deg.	min.
The Latitude being	51	00
The Sun's place	1	00 <i>Aquarius.</i>
The Sun's Altitude	12	00

Then will the *Azimuth* be found to be 56 Deg. from the East or West towards the South; which (by the Points of the Compass upon the Horizon) will appear to be S. E. by S. if in the Morning, or S. W. by S. if in the Evening.

## P R O B. XIX.

To find the Hour of the Day, the Altitude of the Sun given.

*Practice.*] **B**Ring 29 Deg. of *Taurus* to the Meridian, and set the Index to 12 a Clock: Then, if it be in the Forenoon, set the Quadrant of Altitude on the East-side of the Meridian; but on the West-side, if it be in the Afternoon. And turn the Globe about, till the 29 Deg. of *Taurus*, meet with 12 Deg. of the Quadrant of Altitude; and then shall the Index of the Hour-Circle, point at 5 a Clock and 36 Min. if it be in the Morning; or at 24 Min. after 6 of the Clock, if it be at Night. And that is the true Hour of the Day.

In like manner,

	deg.	min.
The Latitude being	51	30
The Sun's place	1	00 <i>Taurus.</i>
The Altitude	36	00

Then

## P R O B. XXI.

*How much must the Sun's Declination increase or decrease, to make the Day Artificial one Hour longer or shorter, than it was at the time proposed.*

**S**uppose in Latitude 51 Deg. 30 Min. the Sun to have 10 Degrees of North Declination, and I would know how much the Declination must increase Northward, to make the Day one Hour longer than it is.

*Practice.*] Elevate the Globe to the Latitude of London, 51 Deg. 30 Min. and bring the Equinoctial Colure to the Meridian; and bring the Sun's place, or the Parallel of 10 Deg. his Declination, to the Horizon; and upon the Horizon make a small mark, to which bring the Equinoctial Colure, and at this Intersection make a mark upon the Colure. Then, (if the days lengthen, move the Globe Eastward, or Westward if they shorten) till 7 Deg. 30 Min. of the Equinoctial have passed the Meridian; and then, again, where the former Colure intersects with the Horizon, make another mark, upon the Colure. This done, bring the Colure to the Meridian again, and see what number of Degrees of the Meridian (or Degrees of the Colure it self) are contained between the two pricks; which you shall find to be 4 Deg. and 40 Min. And so much must the Declination increase Northward, to make the Day lengthen one Hour, at that time of the year.

P R O B.

P R O B. XXIII.

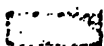
*To find what number of days are contained, between the days of Lengthening or Shortning one Hour, at any time of the Year.*

**L** Et the time be as in the last Example, where the *Sun* hath 10 Deg. of North-Declination; which will be about the 5th of *April*.

*Practice.*] Having made two pricks in the Co-lure, as in the last Example, bring the first prick to the Horizon, where you shall find it to stand against the 5th of *April*. Then move the Globe, till the other prick touch the Horizon; which it will do about the 19th of *April*, at which time, the Day will be one Hour longer than it was upon the 5th of *April*: Between which two Days, there are contained 13 compleat Days, and parts of both the other two Days. So that you may conclude, That in 14 Days time, (at that Season of the year) the Days do lengthen one Hour, and shorten as much when the *Sun* is in opposite Signs.

F

P R O B.



## P R O B. XXV.

*To find the Length of the Longest or Shortest Day in any Latitude.*

**Defini-** **T** *He Longest Artificial Day in any Latitude.] tude, is made by the Sun's passing thro-  
row the Tropick of Cancer, in all Places that have  
North-Latitude, or thro- row the Tropick of Capricorn  
to all that have South-Latitude.*

**Practice.]** To find the length of the Longest Day at *London*, in Latitude 51 Deg. 30 Min. Elevate the Globe thereto, and bring the Solstitial Colure to the Meridian, and the Hour Index to 12. Then, count the number of Hours upon the Tropick of *Cancer*, that are contained thereupon, between the Interfection thereof with the Horizon, on the East-side, and its Interfection on the West-side; which you will find to be 16 Hours, and almost half an Hour, viz. 26 Min. for the length of the Longest Day. And the number of Hours, contained between the East and West Intersections of the Tropick of *Capricorn* and the Horizon, is the length of the Shortest Day, which at *London* will be found to be 7 Hours, and somewhat above half an Hour, viz. 34 Min.

Half the Length of the Day is the time of the *Sun's Setting*, and half the Length of the Night is the time of the *Sun's Rising*.



¶ All the fore-mentioned Problems, may be performed upon either Globe ; the *Horizon*, *Meridian*, *Quadrant of Altitude*, *Hour-Circle*, and most of the Circles upon the Globes themselves, being in both Globes the same. But it is most proper to use the *Terrestrial Globe*, for *Geographical* and *Nautical Problems* ; and the *Celestial Globe* for such as concern *Astronomy* : and these following are chiefly such, and therefore best to be wrought by the *Celestial Globe*.

P R O B. XXV.

*To find the Longitude and Latitude of any Star.*

**Defini-]** **T**He Longitude of a Star, is an Arch of the *Ecliptick*, contained between the beginning of *Aries*, and the Intersection of an Arch of a great Circle, which passeth through both the Poles of the *Ecliptick*, and also through the Body of that Star.

The Latitude of a Star, is that part of an Arch of a great Circle, which passeth through both the Poles of the *Ecliptick*, and through the Body of the Star, and is contained between the *Ecliptick-Line* and that Star.

**Practice.]** For the Longitude, skrew the Quadrant of Altitude over that Pole of the *Ecliptick*, which is nearest to the Star whose Longitude you seek. Then laying the Quadrant just over the Center of the Star, look what Degrees of

Note, That the Poles of the *Ecliptick* are distant from the Poles of the world  $23\frac{1}{2}$  deg. on either side.



the Ecliptick, (counting them from the beginning of *Aries*) and those Degrees, are the Degrees of the Star's *Longitude*. So the Quadrant of Altitude skrewed over the North-Pole of the Ecliptick, and laid upon the Bright Star *Capella*, the Quadrant shall cut 77 Deg. 16 Min. of the Ecliptick-Circle, counted from the beginning of *Aries*; and that is that Star's *Longitude*.

For the *Latitude*, the Quadrant fitted as before, and laid over the Center of *Capella*, the Star shall cut 22 Deg. 50 Min. of the Quadrant of Altitude; and such is the *Latitude* of that Star, North, for it lies on the North-side of the Ecliptick-Line.

## P R O B. XXV.

*To find the Right Ascension and Declination of a Star.*

Definition.] **T**He Right Ascension of a Star, is that Arch of the Equinoctial which is contained between the beginning of *Aries*, and that point which comes to the Meridian with that Star.

The Declination of a Star, is an Arch of the Meridian contained between the Equinoctial and any Star.

Practice.] For the Right Ascension, (the Globe being Rectified) bring *Capella* to the Meridian, and then you shall find 73 Deg. 7 Min. of the Equinoctial contained between the beginning of *Aries* and the Meridian; and that is the Right Ascension of *Capella*.

For

For the Declination, bring *Capella* to the Meridian, so shall you find 45 Deg. 37 Min. of the Meridian, contained between the Equinoctial and *Capella*; and that is the Declination of that Star. And in this manner you may find the Longitude, Latitude, Right Ascension, and Declination of any other Star upon the Celestial Globe: As in this following Table of the principal fixed Stars of the first Magnitude, you shall find.

Stars Names.	Longit.		Latit.			R. Asc.		Decl.		
	deg.	m.	d.	m.		deg.	m.	d.	m.	
<i>Arcturus</i>	119	39	31	2	B	210	13	20	58	B
<i>Lucida Lyra</i>	280	43	61	47	B	276	27	38	30	B
<i>Algol</i>	51	37	22	22	B	41	46	39	39	B
<i>Capella</i>	77	16	22	50	B	73	7	45	37	B
<i>Aldebaran</i>	65	12	5	31	A	64	17	15	48	B
<i>Regulus</i>	145	17	0	26	B	147	43	13	33	B
<i>Cauda Leonis</i>	167	3	12	18	B	173	4	16	25	B
<i>Spica Virgin.</i>	199	16	1	59	A	196	56	9	31	A
<i>Antares</i>	245	13	4	27	A	242	23	25	37	A
<i>Fomalhaut</i>	329	11	21	00	A	339	45	31	17	A
<i>Regel</i>	72	17	31	11	A	74	44	8	37	A
<i>Syrius</i>	99	35	39	30	A	97	42	16	14	A
<i>Procyon</i>	111	18	15	57	A	110	34	6	3	B

P R O B. XXVI.

*To find the distance of two Stars.*

*Practice.*] 1. **I**F the two Stars be both of them under the same Meridian, Bring them under the General (or Brads) Meridian, and see what Degrees of the Meridian are contained between them, for that is their distance.

2. If they lie not under the same Meridian, but have the same Declination, or lie in the same Parallel, Bring one of them to the Meridian, and

see what Degrees of the Equinoctial are cut thereby : Then bring the other Star to the Meridian, and count what Degrees of the Equinoctial, are contained between the Meridian and the Degrees before found, for that is the distance of those two Stars.

3. *If the two Stars do neither lie under the same Meridian, nor in the same Parallel,* Then lay the Quadrant of Altitude (it being loose) to both the Stars, and the Degrees of the Quadrant, contained between the two Stars, is their distance. And if the Quadrant be too short, you may use the Circle of Position, or take their distance with a pair of Calope-Compasses, and measure their distance upon the Equinoctial, or any other great Circle.

Thus,

The Right Shoulder of *Auriga*, and the Right Shoulder of *Orion*, being under the same Meridian, their distance will be found to be 37 Deg. 38 Min.

Also,

*Arcturus* and the Lions Neck, being near in the same Parallel, their distance will be found to be 57 Deg.

Likewise,

*Lyra* the Harp, and *Marchad* in the Wing of *Pegasus*, will be found to be distant 63 Degrees.

F R O B.

P R O B. XXVII.

*To know what Stars will be upon the Meridian at any Hour of the Night.*

*Practice.*] **T**He Sun being in 29 Deg. of *Taurus*, what Stars will be upon the Meridian at 10 a Clock and 12 Min. at Night, bring 29 Deg. of *Scorpio* (which is the opposite Sign to *Taurus*) to the Meridian, and set the Index of the Hour-Circle to 12. Then turn the Globe about Westward, till the Index point at 12 Min. after 10 a Clock, and there hold the Globe; and all those Stars, which lie under the Brass Meridian, are then upon the Meridian, of which *Arcturus* is the Chief.

P R O B. XXVIII.

*To know what Day in the Year any Star shall be upon the Meridian at 12 a Clock at Night.*

*Practice.*] **B**Ring the Star to the Meridian, and mark what Degree of the Ecliptick is just under the Meridian at the same time: Then find that Degree or the Ecliptick in the Horizon, and note what Day of the Year standeth against it, for that Day of the Year will that Star be upon the South-part of the Meridian at 12 at Night: and when the Sun is in the opposite Point of the Ecliptick, the same Star will be upon the North-part of the Meridian at 12 at Noon.

## P R O B. XXIX.

*The Sun's Place, and the Altitude of a known Star given, to find the Hour of the Night.*

**T**He Sun being in 21 Deg. of *Capricorn*, the Altitude of the *Great Dog* 14 Deg. I demand the Hour of the Night.

*Practice.*] The Globe Rectified, &c. bring 21 Deg. of *Capricorn* to the Meridian, and the Index to 12 a Clock. Then move the Globe and Quadrant of Altitude so together, that the *Great Dog* meet with 14 Deg. of the Quadrant; and then shall the Index point at 8 of the Clock and 22 Min. which is the true Hour of the Night.

And thus,

	deg.		deg.		h.m.	
When	20 4	} and the } } Altitude of }	<i>The Bulls Eye</i>	39	} The ho. } } will be }	7. 12
the Sun	20 III		<i>The Bulls Eye</i>	30		9. 2
is in	5 II		<i>Arcturus</i>	50		11. 3

## P R O B. XXX.

*The Altitude of Aldebaran (or any other Star) being given in a known Latitude; to find the Star's Azimuth.*

*Practice.*] **T**HE Quadrant of Altitude being fixed in the *Zenith*, move it and the Globe, till the Degrees of Altitude given, do meet with the Center of the Star; then shall the end of the Quadrant of Altitude, shew you upon the Horizon the *Azimuth* in which the Star then is. And thus, If you bring the Quadrant of Altitude on the East-side of the Globe, moving it and



and the Globe both, till the Center of *Aldebaran* do meet just with 42 Deg. of the Quadrant, you shall then find the Quadrant of the Altitude to rest at 33 Deg. of the Horizon, counted from the East; or at 57 Deg. if you count them from the South: and that is the *Azimuth* of *Aldebaran* when he hath 42 Deg. of Altitude; and that is near the S. E. by E. point of the Compass.

*The Latitude of the Place, (51 Deg. 30 Min.) and the Declination of a Star (suppose the Bulls Eye, Aldebaran) given: To find*

P R O B. XXXI.

*Its Right Ascension.*

*Practice.* **T**HE Globe Rectified to the Latitude, &c. bring *Aldebaran* to the Meridian: Then count how many Degrees of the Equinoctial, are contained between the Meridian and the beginning of *Aries*, which will be 64 Deg. 17 Min. and that is the *Right Ascension* of that Star; which in time, (by allowing 15 Deg. for an Hour, and 1 Deg. for 4 Min. of time) is 4 Hours 16 Min. its *Right Ascension* in time.

And in the same manner may you find,

		deg. min.		h. m.	
The Right Ascension of	{ <i>Arcturus</i> <i>Syrus</i> <i>Algol</i> }	to be	{ 210 13 }	in time	{ 14 1 }
			{ 97 42 }		{ 6 30 }
			{ 40 39 }		{ 2 38 }

P R O B.



## P R O B. XXXII.

*Its Ascensional Difference.*

*Practice.*] **B**Ring the Star to the Meridian, and the Hour-Index to 12: Then bring the Star either to the East or West-side of the Horizon, and there you shall find 1 Hour and 27 Min. contained between the Index and 6 a Clock: and such is the Ascensional Difference of *Aldebaran*.

In like manner, you may find

The Ascensional Difference of	{	<i>Arcturus</i>	}	to be	{	deg. m.	}	or in time	{	h. m.
						28 40				1 55
						21 28				1 26
		<i>Syrius</i>								
		<i>Algol</i>								

*Algol*, his Declination being more than the Complement of the Latitude, never rises nor sets, but is always above the Horizon.

## P R O B. XXXIII.

*Its Amplitude.*

*Practice.*] **B**Ring *Aldebaran* to the Horizon on either side of the Globe, and you shall find it to touch the Horizon at 25 Deg. 56 Min. from the East or West Northward; which is the *Amplitude* of the *Bulls Eye*'s rising or setting. And according to the Points of the Compass it riseth E. N. E. 2 Deg. 26 Min. Northerly; and sets W. N. W. 2 Deg. 26 Min. Northerly.

And

And thus may you find,

			d.	m.
That	{ Arcturus Syrius Algol	Riseth from	Northward	35 6
		the East or	Southward	26 41
		West	Never rises or sets.	

P R O B. XXIV.

*The Semidiurnal Arch, and the time that Aldebaran ( or any other Star ) continues above the Horizon.*

*Practice.*] **B**Ring *Aldebaran* to the Meridian, and set the Hour-Circle to 12. Then turn the Globe Westward, till *Aldebaran* touch the Horizon: then shall the Hour-Index point at 7 Hours 27 Min. And so long time is *Aldebaran* above the Horizon, before he comes to the Meridian; and continues so many Hours and Minutes above the Horizon, after he hath past the Meridian, and sets in the West. And those 7 Hours and 27 Min. is the *Semidiurnal Arch* of that Star; which doubled, is 14 Hours 54 Min. And so long doth that Star continue above the Horizon, after the time of his rising.

And in this manner you may find,

			d. m.			h. m.
The Semi-diurnal Arch of	{ Arcturus Syrius Algol	{ 8 8 8	{ 7.55 4.34 12.00	And his continuance above the Horizon	{ 15.50 9. 8 24.00	

P R O B.

## P R O B. XXXV.

*At what Hour ( any time of the Year ) Aldebaran comes to the Meridian.*

*Practice.*] **L** Et the time be the first of *January*, at which time the *Sun* is in 22 Deg. of *Capricorn*. Bring 22 Deg. of *Capricorn* to the Meridian, and set the Hour-Index to 12. Then turn the Globe about till *Aldebaran* be under the Meridian, and then you shall find the Index to point at 42 Min. after 8 of the Clock, at which time *Aldebaran* will be upon the Meridian that Night.

In like manner you may find, that

					h. m.		
Upon	{	October 28	{	<i>Arcturus</i>	} will be up- on the Me- ridian at	{	11 10
		January 21		<i>Syrius</i>			9 33
		January 1		<i>Algol</i>			7 12

## P R O B. XXXVI.

*At what Hour ( at any time of the Year ) Aldebaran ( or any other Star ) riseth or setteth.*

*Practice.*] **L** Et the time be *January 1*. By the last before-going, you found that *Aldebaran* came to the Meridian at 8 Hour 42 Min. And by the last but one, you found his Semidiurnal Arch to be 7 Hours 27 Min. This being taken from 8 Hours 42 Min. the time of his being South, leaveth 1 Hour 15 Min. the time of its Rising : so that upon the first of *January*, *Aldebaran* did rise at 15 Min. after 1 in the Afternoon. Again, If you add his Semidiurnal Arch 7 Hours 27 Min. to the time of its being South

8 Hours



## P R O B. XXXVIII.

*What Altitude and Azimuth, Aldebaran ( or any other Star) shall have, when six Hours distant from the Meridian.*

*Practice.*] **B**Ring *Aldebaran* to the Meridian, and the Index to 12 : Then turn the Globe about till the Index point at 6 ; then lay the Quadrant of Altitude over the Centre of the Star, and you shall find it to lie under 12 Deg. 18 Min. of the Quadrant : and such is the Altitude of *Aldebaran*. At the same, time look what Degrees of the Horizon are cut by the Quadrant of Altitude, and you shall find 8 Degrees between it and the East or West Points Northwards. And such is the Azimuth of *Aldebaran*.

And according to this Rule you shall find, \ that when

		<i>Altit.</i>		<i>Azim.</i>			
		d.	m.	d.	m.		
<i>Arcturus</i>	} is 6 hours distant } } from the <i>Merid.</i> his }	16	15	76	36	} from the	North.
<i>Algol</i>		12	38	79	43		
<i>Syrus</i> is never 6 Hours distant from the Meridian, nor any other Star that hath South-Declination.							

## P R O B. XXXIX. .

*To find what Altitude and Azimuth any Star hath, when he is at any Horary distance from the Meridian.*

*Practice.*] **T**His is no other than the last. For having brought the Star to the Meridian, and the Index to 12, move the Globe till

till it come to the designed Hour. Then the Quadrant of Altitude, being laid over the Star, shall at the same time shew you both the Altitude and Azimuth thereof as before. This needeth no Example.

P R O B. XL.

*Having the Azimuth of a Star, to find at what Hourly distance that Star is from the Meridian, and what Altitude that Star then hath.*

*Practice.*] **B**Ring the Star to the Meridian, the Index to 12, and the Quadrant of Altitude to the Given Azimuth; then turn the Globe about, till the Center of the Star lie just under the Quadrant of Altitude; the Index at that time shall give the Hourly Distance, and Quadrant the Altitude of the Star.

E X A M P L E.

*Aldebaran* being seen upon 80 Degrees of *Azimuth* from the North-Westward, that is, near upon the W. by N. Point of the Compass; the Star brought to the Meridian, and the Quadrant of Altitude to 80 Degrees, and the Hour-Index to 12. If you bring the Star to the Quadrant of Altitude, you shall find the Index to point at 6 Hours, which is the Star's Hourly Distance from the Meridian. And the Quadrant of Altitude will shew 12 Deg. 18 Min. the Altitude of *Aldebaran* at that time.



## P R O B. XLI.

Concerning the Poetical Rising and Setting of the fixed Stars, viz.

The { Cosmical  
Acronical } Rising and Setting.  
Heliacal }

And how to find either of them by the Globes.

## 1. Of the Cosmical Rising and Setting.

*Definition.* A Star is said to Rise *Cosmically*, when it Riseth with the *Sun*, or with that Degree of the Ecliptick in which the *Sun* then is. And the *Cosmical* Setting is, when a Star setteth in the Morning, or goeth down under the West-Horizon in the Morning at such time as the *Sun* is Rising in the East.

*Practice.* Upon the 27th of *May*, the *Sun* then being in 17 Degrees of *Gemini*, I would know what Stars do then Rise and Set *Cosmically*. Rectifie the Globe to your Latitude, and bring the 11 Deg. of *Aquarius* to the East-part of the Horizon: Then look what Stars are about the Edge of the Eastern Semi-circle of the Horizon, for all those Stars do that Day Rise *Cosmically*. And those Stars which touch or are near the Rim of the West Semi-Circle of the Horizon, do Set at that time *Cosmically*. So shall you find

May 27. { Aldebaran or  
the Bulls Eye,  
with divers  
other smaller Stars, } Rising, and { The right leg  
of Serpentari-  
us and feve-  
ral other  
smaller Stars, } Setting  
Cosmi-  
cally.

## 2. Of

2. *Of the Acronical Rising and Setting of the Stars.*

*Defini-  
tion.*] A Star is said to Rise *Acronically*, when it Rifeth in the East-Horizon, at such time as the *Sun* goes down or Sets in the West-Horizon; and the *Acronical* Setting is when a Star goeth down under the Horizon with the *Sun*.

*Practice.*] Upon the 18th of *October*, in the Latitude of 51 Deg. 30 Min. the *Sun* then being in 5 Deg. of *Scorpio*, I would know what Stars do on that Day Rise and Set *Acronically*. Rectifie the Globe to the Latitude, bringing the place of the *Sun*, 5 Deg. of *Scorpio*, to the West-part of the Horizon; then shall all those Stars which you see on the Verge of the East-side of the Horizon, be Rising *Acronically*. And all those that are about the Verge of the Western part of the Horizon are then Setting *Acronically*. And so upon the forementioned Day, you shall find

A Star in the <i>Whales Tail</i> , and several other smal- ler Stars,	} Rising, and	{ The Tail of the <i>Lion</i> , the South Ballance, and several other smaller Stars,	} Setting <i>Acronically</i> .
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3. *Of the Heliacal Rising and Setting of the Stars.*

*Defini-  
tion.*] A Star is said to Rise *Heliacally*, when having been some time cumbust, (or hid under the *Sun*-Beams) it begins now to appear, being at greater distance from the *Sun*. And a Star is said to Set *Heliacally*, which hath some  
G small

Small time before been seen, but now, by the near approach of the *Sun*, becomes cumbust, and hidden under his Beams. Now to know when a Star begins to become cumbust, and when to be freed from his cumbustment of the Sun-beams, no certain Rule can be given; for the Magnitude of the Star, the Difference of the Climate, the Cloudiness or Serenity of the Air may much alter. But the Opinion of the Ancient Astronomers was, that

			deg.
A Star of the	1	Magnitude may be seen when the Sun is but	12
	2		13
	3		14
	4		15
	5		16
	6		17
			below the Horizon.

And those which are only Nebulous, cannot be seen till the *Sun* be 18 Deg. under the Horizon.

*Practice.*] Rectifie the Globe to the Latitude, and the Quadrant of Altitude in the Zenith; then bring the given Star (suppose *Regulus*, or the *Lions Heart*) to the East-side of the Horizon, and the Quadrant of Altitude to the West-side; then *Regulus*, being a Star of the First Magnitude (by the former Rule of the Ancients) may be seen when the *Sun* is but 12 Deg. below the Horizon: wherefore see what Degree of the Ecliptick doth cut the Quadrant of Altitude in 12 Deg. which you shall find to be 9 Deg. of *Pisces*, the opposite Degree to which is 9 Deg. of *Virgo*; to which Sign and Degree when the *Sun* cometh, (which will be about the 23th of *August*,) then will *Regulus*, or the *Lions Heart*, Rise *Heliacally*: Then for the *Heliacal* Setting, bring the Star to the West-side of the Horizon, and turn the Quadrant



drant of Altitude to the East-side, and see what Degree of the Ecliptick is Elevated upon the Quadrant, as the Magnitude of the *Star* you deal with doth require. For when the *Sun* comes to the opposite Degree of the Ecliptick, that *Star* shall Set *Heliacally*. So

The <i>Pleiades</i>	} shall Rise	{	June 4	} and Set	{	April 20		
<i>Aldebaran</i>			<i>Heliacal-</i>			June 26	<i>Heliacal-</i>	April 22
<i>Arcturus</i>			ly upon			Sept. 26	ly upon	Novemb. 19

¶ *Note*, That if a *Star* Rise *Cosmically* with us, it Sets *Acronically* with our *Antipodes*; and if it Rise *Acronically* with us, it Sets *Cosmically* with our *Antipodes*.

If it Sets *Cosmically* with us, it Riseth *Acronically* with our *Antipodes*; and if it Sets *Acronically* with us, it Riseth *Cosmically* with our *Antipodes* and the contrary.

If a *Star* Rise *Heliacally* with us, it Riseth so with our *Antipodes*; also if it Sets *Heliacally* with us, it Sets so with them.

If a *Star* Rise *Cosmically* with us, it Sets *Acronically* with our *Periæci*; if it Rise *Acronically* with us, it Sets *Cosmically* with our *Periæci*: So if it Sets *Cosmically* with us, it Rises *Acronically* with our *Periæci*; and if it Sets *Acronically* with us, it Rises *Cosmically* with our *Periæci*.

Also if a *Star* Rise *Heliacally* with us, it Riseth so with our *Periæci*; and if it so Sets with us, it so also Sets with them.

But these Poetical Risings or Settings will not agree both to us and to our *Antæci*, as to the same kind, unless a *Star* be in the Equinoctial: But a *Star* may Rise *Heliacally* to us, and *Cosmically* to our *Antæci*, &c. *Heliacal*

and *Cosmical* being neither the same nor contrary. A Star may set *Acronically* to one Country, and Rise *Heliacally* to another the same day, and Rise *Cosmically* to one, and Set *Heliacally* to another.

A Star may Rise *Cosmically* to one, and *Heliacally* to another, and Set *Acronically* to one, and *Heliacally* to another.

There are also Latitudes, wherein any two Stars, which Rise *Cosmically* together, shall Set *Vertically*; that is, when the Westermost is just Setting, the other shall be just in the same *Vertical Circle* or *Azimuth*.

And again, in which those that Rise *Vertically* shall Set *Acronically*, &c. and those which Set *Acronically* shall Rise *Vertically*.

Another way of working several Problems at one Position of the Globe.

P R O B. I.

*The Latitude (51 Deg. 30 Min.) and the Sun's place in the Ecliptick, (29 Deg. of Taurus given; to find*

- I. *The Sun's Declination*; II. *His Right Ascension*; III. *His Meridian Altitude*; IV. *His Distance from the Pole*; V. *His Depression at Midnight*.

*Practice.*] **T**He Globe Rectified, bring 29 Deg. of *Taurus* to the graduated edge of the Meridian; then count upon the said Meridian the number of Degrees contained between the Equinoctial and the *Sun's Place*, which you will

will find to be 20 Deg. for the *Sun's Declination*: Secondly, Reckon the number of Degrees upon the Equinoctial from the first of *Aries* to the Meridian, and that is the *Sun's Right Ascension*, viz. 56 Deg. 30 Min. Thirdly, The number of Degrees on the Meridian contained between the Horizon and the *Sun's Place*, which will be 58 Deg. 30 Min. for the *Sun's Meridian Altitude*: Fourthly, The number of Degrees from the *Sun's Place* to the next Pole, viz. 70 Deg. is his *Distance* from the Pole, (or the Complement of his Declination to 90 Deg.) which if his *Declination* be North, will be to the North-Pole; if South, to the South-Pole: Lastly, Turn the *Sun's Place* to the opposite side of the Meridian, and you have the number of Deg. that the *Sun* Sets below the Horizon, viz. 18 Deg. 30 Min. or his *Depression* at Midnight.

P R O B. II.

*The Sun's place 29 Deg. of Taurus, and the Latitude 51 Deg. 30 Min. given; To find*

- I. *His Amplitude at Rising*: II. *The point of the Compass he riseth upon*: III. *The Hour of his Rising*. IV. *His Oblique Ascension*: V. *His Difference of Ascension*.

*Practice.*] **T**HE Globe Rectified, bring 29 Deg. of *Taurus* to the East-side of the upper Plane of the Horizon, and there fix it; then count the number of Degrees on the Horizon contained between the *Sun's Place* and the East-point of the Horizon, which you will find



to be 34 Deg. towards the North, because the *Sun* is in a Northern Sign: Secondly, Right against the *Sun's* Place, in the Circle of Winds, you will find N. E. by E. for the *Point of the Compass* that the *Sun* riseth upon: Thirdly, Then looking upon the Hour-Circle, the Index will point to the time of the *Sun's* Rising, viz. at 4 of the Clock: Fourthly, The Degrees on the Equinoctial cut by the Horizon, numbered from the beginning of *Aries*, viz. 29 Deg. is the *Sun's* Oblique Ascension; which Subtracted from the Right Ascension, 56 Deg. gives 28 Deg. the Ascensional Difference, which turned into Time, by allowing for every 15 Deg. one Hour of Time, it will make almost 2 Hours that the *Sun* riseth before 6 of the Clock.

## P R O B. III.

To find, I. The time of the *Sun's* Setting: II. His Amplitude: III. The *Point of the Compass* that the *Sun* Sets upon: IV. His Oblique Descension: V. The Ascensional Difference: VI. The length of the Day and Night.

**Pra-** **T**HE Globe Rectified, &c. turn the Globe twice. about Westward until the *Sun's* Place, viz. 29 D. of *Taurus*, comes just to the West-side of the Horizon, and you will find the Index at the Hour-Circle point to about 8 at Night, for the time of the *Sun's* Setting: Secondly, You will find the number of Degrees between the *Sun's* Place, and West-point of the Horizon, to be 34 Deg. for his Setting Amplitude: III. In the Circle of Winds you will find the *Sun's* Place to be right against N. W. by W. for the *Point of the Compass* that the

the *Sun's* upon : Fourthly, You will find the number of Degrees on the Equinoctial from the first Point of *Aries*, cut then by the Horizon, 34 Degrees for his *Oblique Descension* towards the North : Fifthly, You have his *Ascensional Difference* as aforesaid, by Subtracting the *Oblique Descension* from the *Right Descension* : Sixthly, If you count upon the Hour-Circle, the Hours that the Index points to between the *Sun's* Rising and his Setting, you have the Length of the Day, viz. 15 Deg. 30 Min. which subtracted from 24 Hours, gives 8 Hours 30 Min. for the Length of the Night.

## P R O B. IV.

To find the Hour of the Day by the Globe when the Sun shines.

*Practice.*] IF you have a Meridian Line drawn, that is, a Line exactly N. and S. First, Place the Globe so that the Brass Meridian may be directly over it : Secondly, See that the Plane of the Wooden Horizon be parallel to the Natural Horizon, which may be so placed by a Level or Plummets ; then the Poles and Circles of the Globe, will (without any sensible Error) correspond with those in the Heavens : Thirdly, If the *Sun* shines, observe the shadow of the Axis or Pole upon the Hour-Circle, which gives you the Hour of the Day. But if you have no Meridian-Line drawn upon a Plane, where you can conveniently place the Globe, then you may set the four Quarters of the Horizon, viz. N. S. E. W. agreeable to the Four Quarters of the Heavens by your Needle and Compass, especially if you know the Variation of the Needle in that Place.

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But this is only for the Summer Half-year, *viz.* from *March* to *September*. And therefore to find the Hour for the other half-year, you must Depress the Pole as much below the South-part of the Horizon, as before it was Elevated above the Horizon; so will the North-Pole be directly opposite to his first Position, and the Shade of its Axis or Pole, will give the Hour on the Hour-Circle as before.

## P R O B. V.

*The Latitude  $51\frac{1}{2}$  Degrees; the Sun's place 29 Deg. 0 Min. of Taurus, and the Hour given, viz. 10 in the Morn. to find*

*The Sun's Azimuth; The sun's Altitude; And the Point of the Compass he is then upon.*

*Practice.*] **T**HE Globe rectified, the Quadrant of Altitude fixed and brought to the Horizon, move the Globe about (towards the East it being in the Morning, but towards the West if in the Afternoon) till the Index points to the Hour given; then lay the Quadrant of Altitude just over 29 Deg. of *Taurus*, and count the Degrees from the East-point of the Horizon to the graduated Edge of the Quadrant of Altitude, which is the *Sun's Azimuth*, *viz.* 42 Deg. from the East: Then number the Degrees of the Quadrant of Altitude contained between the Horizon and the *Sun's Place*, you will find 51 Deg. for the *Sun's Altitude*, or Height above the Horizon, and the Point of the Compass cut by the Quadrant on the Circle of Winds on the Horizon, is the point of the Compass that the Sun is then upon, Thus



Thus you may find the *Sun's* Height and *Azimuth* at any Hour of the Day, either before, or after Noon: If any Afternoon Hour had been proposed, the Quadrant of Altitude must be turned on the West-side of the Globe, and the *Azimuth* reckoned from the West.

P R O B. VI.

*The Latitude 51½ Deg. The Sun's Place 29 Deg. of Taurus, and the Azimuth 42 Deg. given, to find*

*The Sun's Altitude; Hour of the Day; and the point of the Compass he is upon.*

**T**HE Globe, Quadrant of Altitude, and Hour Index Rectified, turn about the Globe until the *Sun's* Place comes just against the under edge of the Quadrant, and there fix it; then count the number of Degrees upon the Quadrant contained between the Horizon and the *Sun's* place, viz. 51 Degrees for the *Sun's* Altitude; At the same time the Index will point to the Hour 10, and the point of the Compass as before. *Note*, That if the *Azimuth* given be Eastward, the Hour found will be before Noon, if Westward after Noon.

Here *Note*, also, That having the point of the Compass given, you may find the *Sun's* Azimuth, Hour, and Altitude: For 'tis but placing the Quadrant's Edge against the Point of the Compass given, and turning the Globe about until the *Sun's* place comes just to the edge of the Quadrant, and you will find the Requisites to be as aforesaid.

'Tis

'Tis also by this Problem, that the *Sun's* Altitude and Azimuth at 6 of the Clock is found, which can only be in the Summer half year, in places that have North Latitude.

P R O B. VII.

*To find the Altitude, or Height of the Pole by the Globe, when the Sun shines.*

**S**Et the Globe level as by Problem IV. upon some Plane where the *Sun* shines; then turn the North Pole towards the *Sun*, raising the Meridian higher or lower, until you find the Pole cast no shade, that is, until the Rays of the *Sun* fall into the very Axis of the Globe, then the number of Degrees on the Brass Meridian, cut by the Horizon, counted from the Pole, is the Height of the Pole required.

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*Trigonometrical*

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*Trigonometrical Problems.*

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*INTRODUCTION.*

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**S**pherical Triangles are best represented by the Circles upon, and those appendant to the Globes ; with whose nature, affections, and uses, the Practitioner ought thoroughly to be acquainted, before he enter upon the Solution of such Triangles by the Canons or Tables, either of Natural or Artificial Sines and Tangents, or by other Instruments, as Projections, Planispheres, or the like ; the Globe being the Original from whence all these do proceed. For by the true understanding of the Uses of the Globes, it will not be difficult to Project the Sphere *in Plano* upon any Circle, as shall be farther illustrated by the Circles upon the Globe it self ; upon which the Sides and Angles of all Spherical Triangles, are most Naturally represented, and most Expeditiously measured. But before I come to the Practice hereof, give me leave to premise such general and necessary Definitions and Affections, as do in any case belong to Spherical Triangles. And (1.) Of such Lines or (rather) Arches of Circles, of which Spherical Triangles are framed and measured. (2.) Of the Kinds, Parts and Affe-



Affections of such Triangles so constituted : how the things given or required in them are represented upon the Globe ; with the variety of Questions, that the Solution of every Spherical Triangle will afford. With (3.) The Solution of several Problems for Practice.

*Of the Definitions and Affections of Triangles.*

1. **A**LL Triangles do consist of six parts, *viz.* of three Sides, and as many Angles.

2. The three Sides of a Spherical Triangle do consist of three Arches of Great Circles of the Sphere or Globe, each Arch being less than a Semi-circle, or 180 Deg.

3. A Great Circle of the Globe, is that which divideth the Globe into two equal parts ; such are the Equinoctial, Ecliptick, the Colures, or Meridians, the Horizon, the Azimuth or Vertical Circle.

4. The three Angles of a Spherical Triangle, are measured by three Arches of great Circles described upon the three angular Points of the Triangle ; and are either Right, Acute, or Obtuse.

5. A Right Angled Spherical Triangle, is that which hath either one, or more Right Angles, which contains 90 Deg. An Acute Angled Spherical Triangle, is that whose three Angles be all of them Acute ; that is, each of them less than 90 Deg.

6. An Obtuse Angled Spherical Triangle is that whose Angles are all Obtuse, each exceeding 90 Deg. or else mixt, some Obtuse, and some Acute.

7. The Complement of a Side or Angle to a Quadrant or 90 Deg. is so much as that Side or Angle wants of 90 Deg.

8. The

8. The Complement of a Side or Angle to a Semi-circle or 180 Deg. is so much as that Side or Angle wants of 180 Degrees.

9. All Spherical Triangles which have not one or more Right Angles, are called Oblique angled Spherical Triangles.

Hence it followeth, That

1. If two Great Circles of the Sphere, shall pass by each others Poles, those two Circles shall intersect each other at Right Angles. But

2. If two Great Circles of the Sphere do intersect each other, and do not pass through each others Poles, those two Circles shall intersect each other at Oblique Angles. Thus

The General Meridian and the Horizon,	} do intersect each other at Right Angles.
The Colures and the Equinoctial	
The Azimuth, or Vertical Circles and the Horizon,	
The Circle of Latitude and the Ecliptick,	

But

The Colures and the Horizon	} do intersect each other at Oblique Angles.
The Vertical Circles and Equinoctial	
The Circles of Longitude and the Horizon	
Latitude and the Equinoctial	

And the Angles made by these Oblique intersections, are on the one side of the intersection Acute, and on the other side Obtuse. So

3. Two Arches of Great Circles intersecting each other, shall make on both sides the intersection,

section, either two Right Angles, or two Oblique Angles, the one Acute, the other Obtuse ; of which, both of them, being taken together, shall be equal to two Right Angles, or 180 Degrees. Thus, in the Latitude of 51 Deg. 30 Min.

		d. m.	
The Meridian	} intersecting with the Horizon, doth make an <i>Angle</i> of	90 00	} on the one side of the intersection
The Ecliptick		62 00	
The Equino- ctial		38 00	
		deg. min.	
And an Angle of	} 90 00	} on the other side of the intersection.	
			118 00
			141 00

And both the Angles on either side together, are equal to two Right Angles, or 180 Degrees. But here *Note*, That these Angles do vary in every Latitude, and are not always the same.

4. If a Spherical Triangle have three Right Angles, the three sides of that Triangle shall be all Quadrants, each containing 90 Deg. So (in a Parallel Sphere.)

The Brass Meridian, cutting the Horizon in the North and South Points of the Horizon at Right Angles, and the Equinoctial, Colure in the East and West Points of the Horizon at Right Angles, and the Meridian and Colure intersecting each other in the Poles of the World, at Right Angles also : do constitute a Spherical Triangle with three Right Angles ; and the three sides of this Triangle, (for this Reason) shall be all of them Quadrants : for upon the Meridian, between the Equinoctial (which is also the Horizon in a Parallel Sphere) and the Pole, is contained  
90 Deg.

90 Degrees : also upon the Colure, between the Equinoctial and the Pole is also 90 Degrees, and between, the East and North or South Points of the Horizon is also contained 90 Degrees : So that the three Angles being Right Angles, the three Sides are also three Quadrants.

5. If a Spherical Triangle hath two Right Angles, the Sides opposite to those Angles shall be Quadrants ; and the third side shall be the measure of the other Angle. Such Triangles as these do seldom come in Practice, for few or no Questions can arise out of them ; but of Right angled Spherical Triangles, those that have one Right, and two Acute Angles, most Questions are resolvable by.

6. An Acute Angled Spherical Triangle, hath all its sides less than Quadrants, or 90 Degrees.

7. An Obtuse angled Triangle, having all its Angles Obtuse, hath all its Sides more than Quadrants : If mixt, the Side or Sides opposite to the Obtuse Angle or Angles shall be Greater, and the Side or Sides opposite to the Acute Angle or Angles, shall be Less than Quadrants.

8. The Sides of Spherical Triangles, are of the same affection or kind with their opposite Angles.

9. In Right angled Spherical Triangles, the Side which is opposite to the Right Angle, I call the Hypotenuse ; and the other two Sides which contain the Right Angle, I call the Sides or Legs.

10. In Oblique angled Spherical Triangles, I call the Sides Sides, and the Angles Angles, without any other distinction.



11. In the Solution of Right angled Spherical Triangles, there are usually 16 Cases, which will all be reduced to Five ; for that by the Globe three things are at once found. And in Oblique angled Spherical Triangles, there are usually twelve Cases, which by the Globe will be reduced to 6 ; the Globe answering two at one Position.

Thus much of the Definitions and Affections of Spherical Triangles.

*Of the Solution of Spherical Triangles upon the Globe.*

**I**N the following Scheme or Figure of the Sphere or Globe, it being in an Oblique Position, *viz.* Elevated to the Latitude of *London*, 51 Degrees 30 Minutes, you have upon the Superfices thereof divers Spherical Lines and Circles, by the intersections whereof, are constituted divers Spherical Triangles ; some whereof are Right angled, and others Oblique-angled : Of which I shall make use only of Two ; one for the Five Cases of Right-angled Triangles, the other for the Six Cases of Oblique-angled Triangles.

The Triangle which I shall make use of for the Five Cases of Right-angled Triangles, shall be the Triangle P. O. ☉. Right-angled at O.

In which Right-angled Spherical Triangle P.O.⊙.

The Side. { P. ⊙. being an Arch of the Brass Meridian, we suppose to be the Latitude of *London*, 51 deg. 30 min.  
 ⊙. O. being an Arch of the Horizon, we suppose to be the Amplitude of the Sun's Rising or Setting, from the North-part of the Meridian 56 deg. 40 min.  
 P. ⊙. being the Arch of another Meridian, or Hour-Circle, (which the Equinoctial Colure will best supply or represent) we suppose to be the Sun's distance from the Pole, or the Complement of his Declination, 70 deg. 00 min.

{ ⊙. P. O. is the Hour from midnight, whose measure is to be reckoned upon the Equinoctial, between the Equinoctial Colure and the Brass Meridian, and will be 62 deg. 45 min. or in time 4 hours 11 min.

Th Angle. { P. ⊙. O. is the Angle of the Sun's Position at the time of the Question, whose measure is the Arch of a Great Circle, comprehended between the Complement of the side ⊙. O. on the Horizon, and the Complement of the side ⊙. P. on the Equinoctial Colure; both those sides being continued to Quadrants, on the contrary side of the Brass Meridian, and will contain 56 deg. 39 min.

{ P.O. ⊙. is the Right Angle, whose measure is the deg of the Quadrant of Altitude contained between the East and West points of the Horizon and the Zenith, which is 90 deg.

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The several parts of the Triangle being thus declared, let us now proceed to the several Cases which arise out of this, and every Right-angled Spherical Triangle.

*Of Right-angled Spherical Triangles.*

C A S E I.

*The two Sides (or Legs) P. O. 51 deg. 30 min. and  
 O. O. 56 deg. 40 min. being given, to find the Hy-  
 potenuse P. O. and the Angles O. P. O. and  
 P. O. O.*

Seeing that the side P. O. is an Arch of the Brafs Meridian, and contains 51 deg. 30 min. count thereupon from the Pole 51 deg. 30 min. and bring those degrees to the Horizon. Then the side O. O. being an Arch of the Horizon, and contains 56 deg. 40 min. count upon the Horizon, from the Meridian, 56 deg. 40 min. and turn the Globe about till the Equinoctial Colure do touch those degrees of the Horizon, so shall you have the true Triangle perfectly described upon the Globe it self: For from the Pole to the Horizon, upon the Meridian, is equal to P. O. From the Horizon to the Pole, upon the Colure is equal to P. O. And from the Colure to the Meridian, upon the Horizon is equal to O. O. Now (1.) P. O. being 51 deg. 30 min. and O. O. 56 deg. 40 min. the degrees of the Colure counted from the Pole to the Horizon, will be found 70 degrees; for the Hypotenuse P. O. which was required. (2.) For the Angle O. P. O. count the degrees of the Equinoctial which are contained between the Colure and the Brafs Meridian, and you shall find

find them to be 62 deg. 45 min. or 4 hours 11. min. for the quantity of the Angle  $\odot$ . P. O. (3.) For the Angle P.  $\odot$ . O: count the Complement of  $\odot$ . P. 20 degrees upon the Equinoctial Colure, on the other side of the Meridian (so shall that Point be distant from the Point  $\odot$ . 90 deg.) Also, count the Complement of the side  $\odot$ . O. viz: 33 deg. 20 m. upon the Horizon, on the other side of the Meridian, (which Point will be 90 deg. distant from the Point  $\odot$ . upon the Horizon) So shall the distance between these two Points, (measured by the Quadrant of Altitude, or by Compasses) contain, 56 deg. 39 min. for the Angle P.  $\odot$ . O.

Or, This Angle P.  $\odot$ . O. may be otherwise found in the same manner as you found the Angle  $\odot$ . P. O. (but then you must alter the Position of the Globe) For, if you Elevate the Globe to 56 deg. 40 min. the side  $\odot$ . O. and bring the Equinoctial Colure to 51 deg. 30 min. of the Horizon, which is the side P. O. (for so have you turned the Triangle upside-down) then will the degrees of the Equinoctial intercepted between the Equinoctial Colure and the Brass Meridian, be 56 deg. 39 min. as before, and equal to the Angle P.  $\odot$ . O.

Or this is the usual Way taught by others, whereby the Globe must be often Rectified upon every small occasion. But I embrace the first way, as being both Exact and Natural: but having declared both ways, I leave every one at liberty to use that which he best liketh.

So by this one *Data* you have resolved three Problems of the Sphere: for you have found

1. The side  $P. \odot$ . the Complement of the Sun's Declination 70 degrees.
2. The Angle  $\odot.P.O.$  the hour from Midnight 4 hours 11 minutes.
3. The Angle  $P.\odot.O.$  the Angle of the Sun's position 56 degrees 39 minutes.

## C A S E II.

*The Hypotenuse  $P. \odot$ . 70 degrees, and the Side (or Leg)  $P.O.$  51 deg. 30 min. being given; to find the other Leg,  $O. \odot$ . and the Angles  $\odot.P.O.$  and  $O. \odot.P.$*

**T**His Case differeth little from the former: for  $P.O.$  being an Arch of the Meridian, and containing 51 d. 30 m. the Meridian being set thereto in the Horizon, turn the Globe about till 70 deg. of the Equinoctial Colure do touch the Horizon. So shall you find the degrees of the Horizon intercepted between the Colure and the Meridian to be 56 deg. 40 min. for the side  $\odot.O.$  The Angles at  $P.$  and  $\odot$ . are to be found in all respects by their measures, as in the former Case.

And by this one *Data*, you have resolved six other Problems of the Sphere, for by it you have found.



1. ☉. O. the Sun's Amplitude from the North, 56 deg. 40 min.
  2. ☉. P. O. The hour from midnight 62 deg. 45 min. or 4 h. 11 min.
  3. P. ☉. O. The Angle of the Sun's position, 56 deg. 39 min.
- And if instead of Leg P. O. there had been given the Leg ☉. O. you might have then found [by bringing 70 degrees of the Equinoctial Colure, to meet with 56 deg. 40 min. of the Horizon.]
4. P. O. The Latitude 51 deg. 30 min.
  5. ☉. P. O. The hour from midnight.
  6. P. . O. The Angle of the Sun's position 56 deg. 39 min.

### CASE III.

*The Hypothenuse P. ☉. 70 deg. and the Angle P. 62 deg. 45 min. being given, to find the two Legs P. O. and ☉. O. and the Angle P. ☉. O.*

**C**OUNT the Angle P. 62 deg. 45 min. upon the *Equinoctial* from the Colure, and bring that point to the Brass Meridian, and there keep the Globe fast in the Meridian; then move the Brass Meridian upwards or downwards in the Horizon, till 70 deg. of the Equinoctial Colure do justly touch the Horizon, then shall the Brass Meridian rest in the Horizon, at 51 deg. 30 min. for the side P. O. and the degrees of the Horizon, intercepted between the Equinoctial Colure and the Meridian will be 56 deg. 40 min. for the Side ☉. O. and the distance between 33 deg. 20 min of the Horizon, and 20 degrees of the Equinoctial Colure shall be 56 deg. 30 min. for the Angle P. ☉. O.

So that by this single *Data* there are also six other Problems resolved, *viz.* there is found

1. The P. O. the Latitude  $51^{\circ} 30'$  min.
2. The side  $\odot. O.$  the Amplitude from the North  $56^{\circ} 40'$  min.
3. The Anggle P.  $\odot. O.$  the Angle of the Sun's position.

And if instead of the Angle at P. the Angle at  $\odot.$  had been given, you might then have found [by counting  $20^{\circ}$  deg. upon the Equinoctial Colure, and to that point apply  $56^{\circ} 39'$  min. of the Quadrant of Altitude, (or a pair of Compasses opened to that distance,) then turn the Meridian in the Horizon, and the Globe about his Axis, till  $70^{\circ}$  deg. of the Colure and  $00^{\circ}$  deg. of the Quadrant of Altitude do touch the Horizon on either side the Meridian: for then will the Meridian rest in the Horizon, at  $51^{\circ} 30'$  min.

4. The side  $\odot. O.$  the Amplitude from the North  $56^{\circ} 40'$  min.
5. The side P. O. the Latitude  $51^{\circ} 30'$  min.
6. The Angle  $\odot. P. O.$  the hour from midnight  $62^{\circ} 45'$  min.

#### C A S E IV.

One Leg.  $\odot. O.$   $56^{\circ} 40'$  min. and one Angle P.  $\odot. O.$   $56^{\circ} 39'$  min. being given; to find the side P. O., the Hypotenuse P.  $\odot.$ , and the Angle  $\odot. P. O.$

**C**ount upon the Horizon from the Brass Meridian  $56^{\circ} 40'$  min. the given side (or Leg)  $\odot. O.$  also from the Brass Meridian, on the

con-



contrary side thereof, count 33 deg. 20 min. the Complement of  $\odot.O.$  to which degrees apply 00 deg. of the Quadrant of Altitude. Then move the Brass Meridian up and down in the Horizon, till the Equinoctial Colure cuts 56 deg. 40 min. and 56 deg. 39 min. of the Quadrant of Altitude do intersect the Colure. So will the Brass Meridian rest in the Horizon at 51 deg. 30 min. For the side  $P.O.$  the Horizon will cut the Equinoctial Colure in 70 deg. For the Hypotenuse  $P.\odot.$  and the degrees of the Equinoctial intercepted between the Equinoctial Colure and the Brass Meridian, will be 62 deg. 45 min. for the quantity of the Angle  $\odot.P.O.$  which was required.

And by this *Data* there are twelve Problems resolved: for there is found

1. The side  $P.O.$  the Latitude 51 d. 30 min.
2. The Angle  $\odot.P.O.$  the hour from Midnight 62 deg. 45 min.
3. The side  $P.\odot.$  the Sun's distance from the Pole 79 deg.

But if the Given Leg had been  $\odot.O.$  and the Given Angle  $\odot.P.O.$  [by counting the Angle  $P.$  upon the Equinoctial, and bringing that point to the Meridian, and moving the Meridian up and down in the Horizon, till the Equinoctial Colure did touch 56 deg. 40 min. of the Horizon] you should then have found.

4. The Hypotenuse  $P.\odot.$  the Sun's distance from the Pole 70 deg.
5. The side  $P.O.$  the Latitude 51 deg. 30 m.
6. The Angle  $P.\odot.O.$  the Angle of the Sun's position 56 deg. 39 min.

Also if the Hypotenuse  $P.\odot.$  and the Angle  $\odot.P.O.$  had been given [by count-

ing the Angle  $\odot \cdot P \cdot O$  upon the Equinoctial, and bringing it to the Meridian, and moving the Meridian in the Horizon till 70 deg. of the Equinoctial Colure did touch the Horizon] you might then find

7. The side  $\odot \cdot O$  the Sun's Amplitude from the North 56 deg. 40 min.
8. The side  $\odot \cdot P$  the Sun's distance from the Pole 70 den.
9. The Angle  $P \cdot \odot \cdot O$  the Angle of the Sun's position 56 deg. 39 min.  
And again, if the given side (or Leg) had been  $P \cdot O$  and the Angle  $O \cdot \odot \cdot P$  [by setting the Brafs Meridian to 51 d. 30 m. in the Horizon, and turning the Body of the Globe about till the Equinoctial Colure and the Horizon do make an Angle of 56 deg. 39 min.] you might then find
10. The Hypotenuse  $P \cdot \odot$  the Sun's distance from the Pole 70 deg.
11. The side  $\odot \cdot O$  the Sun's Amplitude from the North 56 deg. 40 min.
12. The Angle  $\odot \cdot P \cdot O$  the hour from midnight 62 deg. 45 min.

## C A S E V.

*The two Acute Angles  $\odot \cdot P \cdot O$  62 deg. 45 min. and  $P \cdot \odot \cdot O$  56 deg. 39 min. being given, to find the side  $P \cdot O$   $P \cdot \odot$  and  $\odot \cdot O$ .*

**C**ount the quantity of the Angle  $\odot \cdot P \cdot O$  62 deg. 45 upon the Equinoctial, from the Equinoctial Colure, bringing those degrees to the Meridian, and there fix the Globe; then move the

the Meridian upward or downward in the Horizon, till the intersection of the Equinoctial with the Horizon do make an Angle of 56 deg. 39 min. So shall the side P. O. be found to be 51 deg. 30 min. the Leg  $\odot$ . P. 56 deg. 40 min. and the Hypotenuse P.  $\odot$ . 70 deg.

And from this *Data*, three Problems are resolved: for you have found

1. The side P. O. the Latitude 51 deg. 30 min.
2. The side  $\odot$ . P. the Amplitude from the North 56 deg. 40 min.
3. The Hypotenuse P.  $\odot$ . the Sun's distance from the Pole 70 deg.

This last Case may best be resolved by changing of the Angles into Sides, as shall be hereafter taught.

These are the Five Cases of Right-angled Spherical Triangles: And here you see that in this one Right-angled Spherical Triangle, by the several Parts given in these Five Cases, there are 30 Spherical Problems resolved: Namely, 3 by the First Case, 6 by the Second, 6 by the Third Case, 12 by the Fourth Case, and 3 by the Fifth Case. And so many are resolvable in every Right angled Spherical Triangle.

*Of Oblique-angled Spherical Triangles.*

**T**He Triangle which I shall make use of for the resolving of the Six Cases of Oblique-angled Spherical Triangles, shall be the Oblique Triangle Z. P. E. Obtuse angled at Z.

In which Triangle

- |           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The Side  | <p>Z. P. being an Arch of the Brass Meridian, we will suppose to be the Complement of the Latitude of <i>London</i>, containing 38 deg. 30 min.</p> <p>P. E. being an Arch of a Meridian (or Hour-Circle) we will suppose to be the Sun's distance from the Pole, or the Complement of the Sun's Declination Northward 70 deg.</p> <p>Z. E. being an Arch of an Azimuth (or Vertical Circle) let be the Complement of the Sun's, or a Star's Altitude, and to contain 47 deg. 12 min.</p>                                                    |
| The Angle | <p>Z. P. E. is the Hour from Noon, whose measure is to be reckoned upon the Equinoctial, between the Equinoctial Colure and the Brass Meridian, and will be found to be 45 deg. or 3 hours in time.</p> <p>E. Z. P. is the Sun's Azimuth from the North part of the Meridian, and is to be measured upon the Horizon between the North-part of the Brass Meridian, and the Quadrant of Altitude, and will be found to be 15 deg. 25 min.</p> <p>Z. E. P. is the Angle of the Sun's Position at the time of the Question, and may be mea-</p> |

measured either by turning of the Quadrant of Altitude to the contrary side of the Meridian, and counting thereupon the Complement of the side  $E. Z.$  42 degrees, 48 min. and the Complement of the side  $Z. P.$  20 deg. upon the Colure; and the distance of these two Points shall be the measure of the Angle  $Z. E. P.$  which will be found to contain 36 deg. 52 min. Or, you may turn the Triangle, and place  $Z. E.$  in the place where before  $Z. P.$  was placed, and then may that Angle be measured upon the Equinoctial between the Colure and the Brass Meridian, as the Angle  $Z. P. E.$  was.

The several Sides and Angles of this Triangle being discovered, I will now come to shew the several Cases which will arise out of this, and every Oblique Spherical Triangle: But first let me shew you

*How to express the Triangle upon the Globe.*

Elevate the Pole of the Globe to the Complement of any of the Sides of the Triangle, as in this Example, to 51 deg. 30 min. (which is the Complement of the side  $Z. P.$ ) then count the side  $Z. P.$  38 deg. 30 min. from the Pole, and thereto screw the Quadrant of Altitude. This done, count the side  $E. P.$  70 deg. upon the Equinoctial Colure from the Pole, and the Side  $Z. E.$  upon the Quadrant of Altitude from the Zenith downward, and so move the Globe and Quadrant of Altitude together, till the numbers counted upon both of them concur in one Point; and so shall



shall you have your Triangle exactly delineated upon the Globe; which being done, I proceed to the Six Cases of Oblique-angled Spherical Triangles, and to shew the Variety of Problems that will naturally arise out of the solving of every such Oblique Triangle.

## C A S E I.

*The Side Z. P. 38 deg. 30 min. The Side E. P. 70 deg. and the Side Z. E. 47 deg. 12 min. being given, to find the Angles.*

**E**LEVATE the Globe to the 51 deg. 30 min. the Complement of Z. P. and count the side Z. P. the Complement of the Latitude 38 deg. 30 min. from P. to Z. and there fasten the Quadrant of Altitude. Then count the Side E. P. the Complement of the Sun's Declination 70 deg. upon the Colure from the Pole downwards: Also count the Complement of the Sun's Altitude 47 deg. 12 min. The Side Z. E. upon the Quadrant of Altitude downwards; and move the Globe and Quadrant together till 70 deg. of the Colure, and 47 deg. 12 min. of the Quadrant do meet: So is your Triangle represented upon the Globe.

Now to find the several Angles.

1. For the Angle at Z. count the number of degrees of the Horizon, which are contained between the North-part of the Meridian, and the Quadrant of Altitude; and you shall find them to be 115 deg. 35 min. and that is the quantity of the Angle E. Z. P. and is the Sun's Azimuth from the North-part of the Meridian. 2. For the Angle Z. P. E. count the number of degrees of the Equi-

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Equinoctial, which are contained between the South-part of the Meridian and the Colure; which you will find to be 45 deg. and that is the quantity of the Angle Z. P. E. which is the Hour from Noon, namely 9 in the Morning, or 3 in the Afternoon. 3. For the Angle Z. E. P. (either change the Triangle by elevating the Globe anew, or) count 42 deg. 48 min. the Complement of Z. E. upon the Quadrant of Altitude (it being brought to the other side of the Meridian) and also count the 20 deg. the Complement of E. P. upon the Colure, (on the other side of the Meridian) the distance between these two points, measured by Compasses or otherwise, will be found to contain 36 deg. 52 min. equal to the Angle Z. E. P. which is the Angle of the Sun's or Star's Position at the time of the Question.

And thus by this one *Data*, you have resolved three Problems : For you have found

1. The Angle E. Z. P. the Sun's Azimuth 115 deg. 35 min.
2. The Angle Z. P. E. the Hour 45 deg. or 9 or 3 a Clock.
3. The Angle Z. E. P. the Sun's Angle of Position 36 deg. 52 min.

C A S E

## C A S E II.

*The two Sides E. Z. 47 deg. 12 min. Z. P. 38 deg. 30 min. and the Angle comprehended between them being given, to find the other parts of the Triangle.*

**C**ount P. Z. 38 deg. 30 min. (the Globe being elevated to the Complement thereof) upon the Meridian, from P. to Z. and there fix the Quadrant of Altitude: Then from the North-part of the Meridian upon the Horizon, count the quantity of the Angle E. Z. P. 115 deg. 35 min. and thereto bring the Quadrant of Altitude: Then count the other given Side E. Z. 47 deg. 12 min. upon the Quadrant of Altitude downwards; and turn the Globe about till the Equinoctial Colure cut the Quadrant of Altitude in 47 deg. 12 min. So is your Triangle delineated upon the Globe.

Now to find the several Parts.

1. The Degrees of the Colure contained between the Pole and the Quadrant being 70, is the Side E. P. 2. The Degrees of the Horizon between the Meridian and Quadrant being 115 deg. 35 min. is the Angle E. Z. P. And 3. The distance between the Complement of E. Z. upon the Quadrant of Altitude, and the Complement of E. P. upon the Colure (they being both continued to Quadrants, on the other sid of the Meridian) will be found 36 deg. 52 min. which is the Angle Z. E. P.

Thus

Thus by this *Data* you have found

1. E. P. The Complement of the Sun's Declination.
2. E. Z. P. The Sun's Azimuth from the North.
3. Z. E. P. The Angle of the Sun's or Star's Position.  
But if the Sides Z. P. P. E. and Angle Z. P. E. had been given, there would then have been found
4. P. E. Z. The Angle of Position.
5. E. Z. The Complement of the Sun's Altitude.
6. E. Z. P. The Azimuth from the North.  
Or if the Sides Z. E. P. E. and Angle Z. E. P. had been given, there would then be found
7. E. Z. P. The Sun's Azimuth from the North.
8. Z. P. The Complement of the Latitude.
2. Z. P. E. The Hour from Noon.

C A S E III.

*The two Angles E. Z. P. 154 deg. 25 min. and Z. P. E. 45 deg. with the Side Z. P. 38 deg. 30 min. comprehended between them, given, to find the other parts of the Triangle.*

Count 38 deg. 30 min. the side Z. P. upon the Meridian from the Pole, and thereto screw the Quadrant of Altitude; then count 45 deg. the Angle Z. P. E. upon the Equinoctial, (beginning at the Colure) and bring those 45 deg. to the

the South-part of the Brass Meridian. Again, count 115 deg. 35 min. the Angle E. Z. P. upon the Horizon, from the North-part of the Meridian, and thereto bring the Quadrant of Altitude. And so have you represented your Triangle upon the Globe,

Now to find the other Sides and Angles.

1. The Degrees contained between the Pole and the Colure upon the Quadrant; namely, 47 deg. 12 min. will be the Side Z. E. 2. And the Degrees between the Pole and the Quadrant upon the Colure, *viz.* 70, will be the Side E. P. 3. And the distance between the Complements of the Sides E. Z. and E. P. being continued to Quadrants on the other side of the Meridian; namely, 36 deg. 52 min. will be the Angle Z. E. P.

And by this *Data*, you have found

- |                                                           |                                                                                                       |
|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| 9. {                                                      | 1. Z. E. The Complement of the Sun's Altitude.                                                        |
|                                                           | 2. E. P. The Distance of the Sun from the Pole.                                                       |
|                                                           | 3. Z. E. P. The Angle of the Sun's Position.                                                          |
|                                                           | But if the Side E. P. and the Angle Z. E. P. and Z. P. O. had been given, there would have been found |
|                                                           | 4. E. Z. The Complement of the Sun or Stars Altitude.                                                 |
|                                                           | 5. E. Z. The Sun's or Stars Azimuth from the North.                                                   |
|                                                           | 6. Z. P. The Complement of the Latitude.                                                              |
|                                                           | And if the Side Z. E. and the Angles P. Z. E. and P. E. Z. had been given, you might then find        |
|                                                           | 7. Z. P. The Complement of the Latitude.                                                              |
| 8. Z. P. E. The Hour from Noon.                           |                                                                                                       |
| 9. P. E. The Complement of the Sun's or Stars Declination |                                                                                                       |

CASE



CASE IV.

*The two Sides Z. P. 38 deg. 30 min. and E. P. 70 deg. with the Angle Z. E. P. 36 deg. 52 min. being given, to find the other Side and Angles.*

**T**O resolve this *Case*, you may (if you please) revert the Triangle, by elevating the Globe to 20 deg. the Complement of the given Side P. E. then counting 70 deg. the Side E. P. upon the Meridian from the Pole, there screw the Quadrant of Altitude. Then upon the Horizon, count 36 deg. 52 min. the given Angle E. and to them bring the Quadrant of Altitude. So have you fixed the Angle Z. E. P. Then turn the Globe about, till 38 deg. 30 min. the other given Side P. Z. do touch the Quadrant, which it will do in 47 deg. 12 min. for the Side E. Z. And for the Angle P. the degrees of the Equinoctial between the Meridian and the Colure, *viz.* 45, is the Angle at P. and for the Angle at Z. it may be found by reverting of the Triangle again, or by the Complements of the Sides extended on the other side of the Meridian, as hath been before taught. Lastly, for the Side E. Z. you have it upon the Quadrant 47 deg. 12 min.

The Triangle being thus delineated, you have found, (1.) the Side E. Z. 47 deg. 12 min. (2.) the Angle P. 45 deg. (3.) the Angle E. Z. P. 154 deg. 25 min.

¶ I thought good in this place to insert this manner of Change, not only for variety, but because in this and the next Case the Triangle may be more readily delineated upon the Globe.

And in this one *Data* you have found

1. *E. Z.* The Complement of the Sun's Altitude.

2. *Z. P. E.* The Hour from Noon.

3. *E. Z. P.* The Azimuth of the Sun or a Star from the North.

But if the Sides *Z. P.* and *E. P.* and the Angle *E. Z. P.* had been given, you would then have found

4. *E. Z.* The Complement of the Sun's or Star's Altitude.

5. *Z. E. P.* The Angle of the Sun's or Star's Position.

6. *Z. P. E.* The Hour from Noon.

And if there had been given *E. P.* *E. Z.* and *E. Z. P.* then would have been found

7. *Z. P.* The Complement of the Latitude.

18 8. *Z. P. E.* The Hour from Noon.

9. *Z. E. P.* The Angle of Position.

In like manner, if *P. E.* *E. Z.* and *Z. P. E.* had been given, you would have found

10. *Z. P.* The Complement of the Latitude.

11. *Z. E. P.* The Azimuth from the North.

12. *Z. E. P.* The Angle of Position.

Again, if there had been given *E. Z.* *Z. P.* and *Z. P. E.* you might then find

13. *P. E.* The Sun's distance from the Pole.

14. *Z. E. P.* The Angle of Position.

15. *E. Z. P.* The Azimuth from the North.

Lastly, If *E. Z.* and *Z. P.* and the Angle *Z. E. P.* had been given, there would have been found

16. *P. E.* The Complement of the Sun's or or Stars Declination.

17. *Z. P. E.* The Hour from Noon.

18. *E. Z. P.* The Azimuth from the North.

C A S E

CASE V.

The two Angles  $E. Z. P.$   $115 \text{ deg. } 35 \text{ min.}$   $Z. P. E.$   $45 \text{ deg.}$  with the Side  $P. E.$   $70 \text{ deg.}$  being given, to find the rest of the Triangle.

**E**levate the Globe to  $20 \text{ deg.}$  the Complement of the Side  $E. P.$  Then count the given Side  $E. P.$   $70 \text{ deg.}$  upon the Meridian, from  $P.$  to  $Z.$  and there fix the Quadrant. Then the given Angle  $E. P. Z.$  being  $45 \text{ deg.}$  count  $45 \text{ deg.}$  upon the Equinoctial from the Colure, and bring that point under the Meridian: So have you constituted the Side  $E. P.$  and the Angle  $E. P. Z.$  Now for the Angle  $E. Z. P.$  you must either revert the Triangle again, or find it by the Complements of the Sides  $Z. E.$  and  $Z. P.$  extended to Quadrants on the other side of the Meridian, which you shall find to be  $115 \text{ deg. } 35 \text{ min.}$

The Triangle thus constituted, (1.) For the Side  $Z. P.$  the degrees of the Colure between the Pole and the Quadrant being  $38 \text{ deg. } 30 \text{ min.}$  is that Side. (2.) The degrees of the Quadrant of Altitude, between the Zenith and the Colure, being  $47 \text{ deg. } 12 \text{ min.}$  is the Side  $E. Z.$  (3.) The degrees of the Horizon between the Meridian and the Quadrant of Altitude being  $36 \text{ deg. } 52 \text{ min.}$  is the quantity of the Angle  $Z. E. P.$

By which single *Data*, you have found

- 1.  $Z. P.$  The Complement of the Latitude.
- 2.  $E. Z.$  The Complement of the Altitude.
- 3.  $Z. E. P.$  The Angle of Position.

But if the Angles  $E. Z. P.$   $Z. P. E.$  and the Side  $Z. E.$  had been given, then might you find

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A.  $Z. P.$



4.  $Z. P.$  The Complement of the Latitude.
5.  $P. E.$  The Sun's distance from the Pole.
6.  $Z. E. P.$  The Angle of Position.  
Or had there been given  $Z. P. E.$   $Z. E. P.$   
and the Side  $E. P.$  you might from thence  
find
7.  $Z. P.$  The Complement of the Latitude.
8.  $E. P.$  The Complement of the Sun or Star's  
Declination.
9.  $E. Z. P.$  The Sun's Azimuth from the  
North.  
And if the Angles  $Z. P. E.$   $Z. E. P.$  with  
the Side  $Z. P.$  had been given, then would  
have been found
10.  $Z. E.$  The Complement of the Sun's Al-  
titude.
11.  $P. E.$  The Sun's distance from the Pole.
18. 12.  $E. Z. P.$  The Sun's Azimuth from the  
North.  
But if the Angles  $Z. E. P.$   $E. Z. P.$  and  
the Side  $Z. P.$  had been given, then you  
might find
13.  $Z. E.$  The Sun's distance from the Ze-  
nith.
14.  $P. E.$  The Sun's distance from the Pole.
15.  $Z. P. E.$  The Hour from Noon.  
And lastly, had there been given the An-  
gles  $Z. E. P.$   $E. Z. P.$  and the Side  $P. E.$   
then might be found
16.  $Z. E.$  The Complement of the Sun's or  
Star's Altitude.
17.  $Z. P.$  The Complement of the Latitude.
18.  $Z. P. E.$  The Hour from Noon

C A S E VI.

*The three Angles E. Z. P. 115 deg. 35 min. the Angle E. P. Z. 45 deg. and the Angle Z. E. P. 36 deg. 52 min. being given, to find the three Sides.*

**T**His Case may best be resolved by turning the Angles of the Triangle into Sides, as shall be taught by and by: and so by this *Data* you may find

1. Z. E. The Complement of the Sun's Altitude.
2. Z. P. The Complement of the Latitude.
3. E. P. The Complement of the Sun's Declination.

And thus have you, out of this one Oblique Spherical Triangle, by the variety that these Six Cases afford, no less than Threescore Problems resolved, *viz.* 3 in the First Case, 9 in the Second Case, 9 in the Third Case, 18 in the Fourth Case, 18 in the Fifth Case, and 3 in the Sixth Case; in all 60. And so many Varieties or Changes are there in every Oblique-angled Spherical Triangle— And besides these Varieties, this Triangle Z E P, is not peculiar only to the Appellations that I have here given them, but to other purposes also. For,

This Oblique-angled Triangle is not capable only of resolving the forementioned Astronomical Questions, but may be applied to Geographical or Nautical Questions also. For,

1. The Side Z P, may represent the Complement of the Latitude of that Town or City whose Zenith-point is Z.
2. The



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2. The Side  $EZ$ , may represent the distance between those two Cities or Towns.
3. The Side  $PE$  will be the Complement of the Latitude of that City or Town at  $E$ .
4. The Angle  $EPZ$ , is the difference of Longitude between the two places  $E$  and  $Z$ .
5. The Angle  $PZE$ , the Point of the Compass leading from  $Z$  to  $E$ .
6. The Angle  $PEZ$ , the Point of the Compass leading from  $E$  to  $Z$ .

And in this Triangle the same things being given, they may be varied as before, and afford as many Questions in Geography or Navigation as in Astronomy : Namely 60.

Moreover, In the same Triangle, if you imagine the Side  $PZ$  to be 23 deg. 30 min. the Distance of the Pole of the World, from the Pole of the Ecliptick : Then will

1. The Side  $ZP$ , be the distance of the Pole of the World from the Pole of the Ecliptick:
2. The Side  $PE$  will be the Complement of the Declination of a Star at  $E$ .
3. The Side  $ZE$  will be the Northern Latitude of the Star at  $E$ .
4. The Angle  $EPZ$  will be the Complement of the Star's Right Ascension.
5. The Angle  $PZE$  is the quantity of the Star's Longitude.
6. The Angle  $PEZ$  is the Angle of the Star's Position.

And this way it will afford 60 Varieties more, as is before intimated.

Theorem

Theorem.

*The Sides of any Spherical Triangle, may be turned into Angles; & contra, the Complement of the Greatest Side, or Greatest Angle (to a Semicircle) being taken for the Greatest Side, or Greatest Angle.*

Demonstration.

**L** Et A B C, be a Spherical Triangle Obtuse-angled at B. And let

$\left. \begin{array}{l} D E \\ H I \\ G F \end{array} \right\}$  be the Measure  $\left. \begin{array}{l} A \\ C \\ B \end{array} \right\}$  of the Angle  $\left. \begin{array}{l} A \\ C \\ B \end{array} \right\}$  viz. of its Complement, F B G, it being the Angle of the Triangle.

Now,

$\left. \begin{array}{l} K L \\ L M \\ K M \end{array} \right\}$  is equal to  $\left. \begin{array}{l} D E \\ F G \\ H I \end{array} \right\}$

Because

$\left. \begin{array}{l} K D \\ L G \\ R I \end{array} \right\}$   $\left. \begin{array}{l} L E \\ F M \\ M H \end{array} \right\}$  are Quadrants, and  $\left. \begin{array}{l} L D \\ L F \\ K H \end{array} \right\}$  their common Complement is

Therefore, The Sides of the Triangle K L M, are equal to the Angles of the Triangle A B C, taking for the Greatest Angle A B C, the Complement thereof F B G.

It may also be demonstrated, That the Sides of the Triangle A B C, are equal to the Angles of the Triangle K L M, by the converse of the former. For

The side  $\left\{ \begin{array}{l} A B \\ B C \\ A C \end{array} \right\}$  is equal to  $\left\{ \begin{array}{l} O P \\ F H \\ D I \end{array} \right\}$  the measure of the Angle  $\left\{ \begin{array}{l} M L K \\ L M K \\ D K I \end{array} \right\}$  of the Complement of the Obtuse Angle  $D K I$ .

For,  
 $\left\{ \begin{array}{l} A D \\ A P \\ B F \end{array} \right\}$  and  $\left\{ \begin{array}{l} C I \\ O B \\ C H \end{array} \right\}$  are Quadrants, and their common Complement is  $\left\{ \begin{array}{l} C D \\ A O \\ C F \end{array} \right\}$ .

Therefore, The Sides may be turned into Angles, and the contrary; which was to be demonstrated. And by this Conversion, may the Fifth Case of Right, and the Sixth Case of Oblique Spherical Triangles be resolved.

*How a Perpendicular is to be let fall in any Oblique Spherical Triangle, thereby dividing it into two Right-angled Triangles.*

**T**HIS Problem is not of any Use in the Solution of Triangles by the Globe, as is evident by what hath been already delivered concerning the Solving of them: But for that in Trigonometrical Calculations, there is a necessity for so doing, and the doing of it no less difficult to conceive or imagine; and seeing how naturally, and lively it is represented upon the Globe, I will therefore here insert it. And it is grounded upon the First Theorem at the beginning of this Tract of Trigonometry, viz.

*If two Great Circles of the Sphere shall pass through each others Poles, those two Circles shall cut each the other at Right Angles.*

In the Oblique-angled Triangle  $ZEP$ , before made use of, let there be given, 1. The Side  $PZ$ . 2. The Side  $EZ$ ; And 3. The Angle  $EPZ$ . and let it be required to find the Side  $PE$ . This Problem is done by the Globes, by the Fourth Case, as you may see, without the help of any Perpendicular; but in Calculation it is wholly necessary, and therefore may well deserve the place of a Problem here.

The Triangle being described upon the Globe, let it be required to let fall a Perpendicular from the Angle  $Z$ , upon the Side  $EP$ : The Measure of the given Angle  $P$ , being upon the Equinoctial, see upon the Globe where the Side  $PE$  (being extended) cuts the Equinoctial, and from that Point count 90 deg. upon the Equinoctial, and that Point shall be the Pole of the Circle ( $PE$ .) (*For the Poles of all Great Circles are a Quadrant, or 90 Deg. distant from their Peripheries:*) wherefore the Quadrant of Altitude being fixed in  $Z$ , bring it to this Point found in the Equinoctial, and then will it cut the Side  $EP$  in the Point where the Perpendicular must fall, which will be at  $K$ , 29 deg. 12 min. distant from  $P$ .

### CONCLUSION.

**I**N the foregoing Precepts, I have made use only of two Triangles for the Solution of the Five Cases of Right, and Six Cases of Oblique-angled Spherical Triangles; namely, of the Triangle  $P \odot \odot$  for Right-angled, and  $ZEP$  for Oblique-angled. Yet in the Figure of the Globe by the Intersection of the several Circles thereof, there are divers other Triangles (both Right and Oblique).



Oblique) constituted, all which the foregoing Rules and Cases will sufficiently Solve. A few of the Principal I will mark in the Globe by numerical Figures, for distinction, and give you an account of what Circles they are composed, and what Questions of the Globe are Resolvable thereby.

The Triangle that I have made use of for Right-angled Triangles, viz.  $P \odot O$ , I have marked with Figure 1. And the Oblique Triangle  $ZEP$ , with the Figure 2; and shall say no more of them, having sufficiently dealt with them already; but come to give you an account of such other as I have marked in the Figure. And,

The first that I shall take notice of is, The Triangle  $AKM$ , marked with the Figure 3. Right-angled at  $M$ , which is constituted of

$AK$  an Arch of the Equinoctial,

$AM$  an Arch of the Ecliptick, and

$KM$  an Arch of a Circle of Longitude passing through the Poles of the Ecliptick.

In this Triangle,

The Side  $AM$ , is the Sun's or a Star's Longitude, or Distance from the Equinoctial Point  $A$ .

The Side  $\left\{ \begin{array}{l} KM \text{ is the South Latitude of a Star at } M, \\ \text{or the Sun's South Declination.} \\ AK \text{ is the Right Ascension.} \end{array} \right.$

The Angle  $\left\{ \begin{array}{l} KAM \text{ is the Sun's greatest Declination.} \\ AKM \text{ the Angle the Circle of Longitude} \\ \text{makes with the Equinoctial.} \\ AMK \text{ is a Right Angle.} \end{array} \right.$

The



The second Triangle that I shall take notice of is  $A \odot B$ , Right-angled at  $B$ , and marked with the Figure 4, and which is constituted of

- $A \odot$ , an Arch of the Horizon.
- $A B$ , an Arch of the Equinoctial, and
- $B \odot$ , an Arch of a Meridian or Hour-Circle.

In this Triangle,

The side  $\left\{ \begin{array}{l} A \odot \text{ is the Amplitude of the Sun's Rising or} \\ \text{Setting from } A, \text{ the East or West-Points} \\ \text{of the Horizon.} \\ B \odot \text{ is the Sun's Declination North.} \\ A B \text{ is the Ascensional Difference.} \end{array} \right.$

The Angle  $\left\{ \begin{array}{l} \odot B A \text{ is a Right Angle.} \\ \odot A B \text{ is the Complement of the Latitude.} \\ A \odot B \text{ is the Angle of the Sun's Position at} \\ \text{his Rising.} \end{array} \right.$

The Third Triangle that I here take notice of, is the Triangle  $A L F$ , Right-angled at  $F$ , and marked with the Figure 5. The which is constituted of

- $A L$ , an Arch of the Equinoctial Colure.
- $A F$ , an Arch of the Horizon, and
- $L F$ , an Arch of an Azimuth or Vertical-Circle.

In this Triangle,

The side  $\left\{ \begin{array}{l} A F \text{ is the Sun's Azimuth being East or West.} \\ A L \text{ is the Sun's Declination North.} \\ L F \text{ is the Sun's Altitude at Six a Clock.} \end{array} \right.$

The Angle  $\left\{ \begin{array}{l} L F A \text{ is a Right Angle.} \\ L A F \text{ is the Latitude.} \\ A L F \text{ is the Angle of Position.} \end{array} \right.$

The

The Fourth and last Triangle that I shall mention, is  $ADC$ , Right-angled at  $C$ , and marked with the Figure 6, and is composed of

$AD$ , an Arch of the Prime Vertical-Circle or Azimuth of East or West.

$AC$ , an Arch of the Equinoctial.

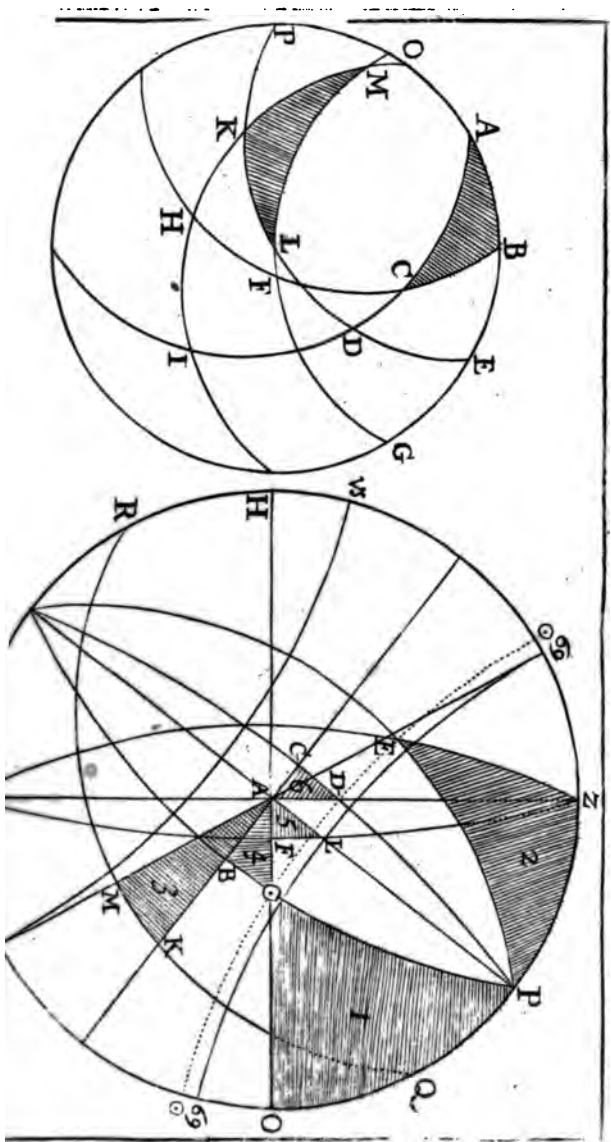
$DC$ , an Arch of a Meridian or Hour-Circle

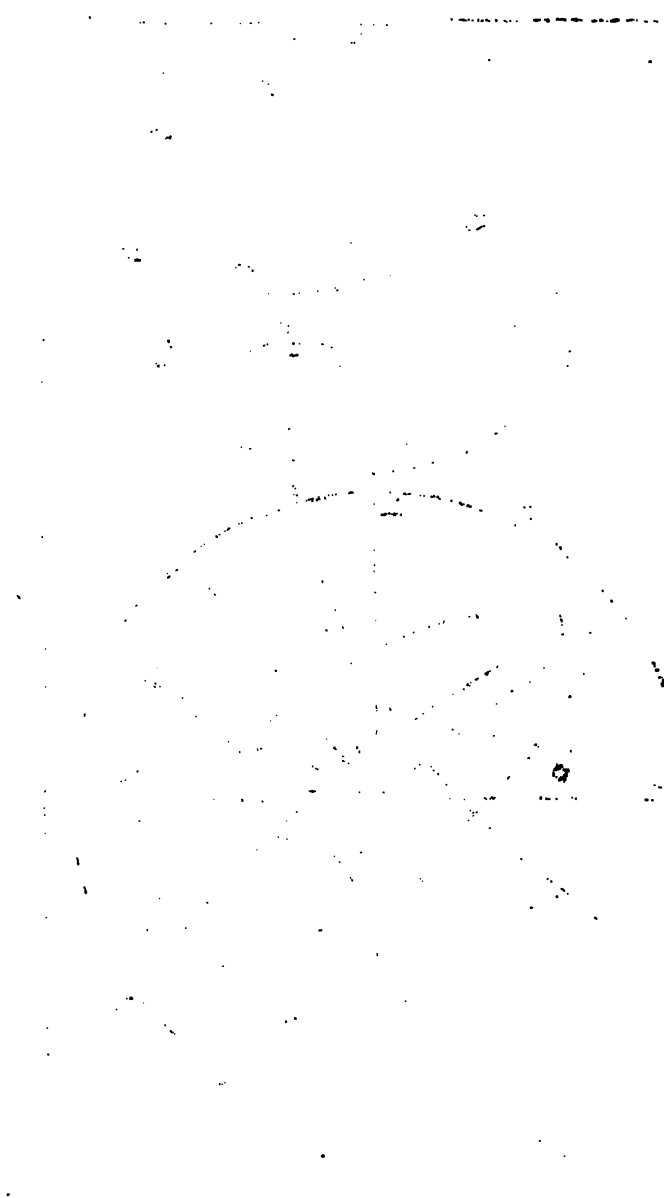
In which Triangle,

The side  $\left\{ \begin{array}{l} AD \text{ is the Sun's Altitude when he is due East or West.} \\ AC \text{ is the Ascensional Difference.} \\ DC \text{ is the Sun's Declination North.} \end{array} \right.$

The Angle  $\left\{ \begin{array}{l} ADC \text{ is a Right Angle.} \\ CDA \text{ an Angle of Position.} \\ DAC \text{ is the Latitude.} \end{array} \right.$

Thus have you an account of Four other Right-angled Spherical Triangles, with the Affections or Natures of their respective Sides and Angles; out of each of which, by the Varieties that will arise from the Five Cases, may be deduced 30 Problems, and in all the Four Triangles 120 Problems, all which may be performed according to the Directions of the Five Cases of Right-angled Spherical Triangles; the Exercising whereof I leave to the Practitioner.—— There are divers other Triangles may be found both Right and Oblique-angled, but these as the principal I commend to the Practice of the young *Tyrol*.





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## *Horologiographical Problems.*

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### INTRODUCTION.

*Of the Distinction of Plains, upon which Dials are to be made.*

**A**LL Plains upon which Dials are made, in any Latitude or part of the World, do either lie, 1. Parallel to the Horizon, or 2. are Perpendicular to the Horizon; or 3. do cut the Horizon at Oblique Angles: and of these sorts of Plains there are several Varieties, excepting the first.

1. A Plain that lieth Parallel to the Horizon, is said to be an Horizontal Plain; and of this kind there is no variety.

2. Of Plains that are Perpendicular to the Horizon there are Two Varieties: For,

First, If the Plain which is Perpendicular to the Horizon, do stand directly in the Azimuth, or Vertical-Circle, of East and West, the two Faces thereof beholding, one the South, and the other the North — Or if the Perpendicular Plain do stand in the Meridian of the Place, that is, in the Azimuth of North and South, and so the two  
Faces



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Faces thereof do behold the East and West——  
Such Plains are called direct Vertical Plains, because they have a direct respect to the four Cardinal Points of Heaven, *viz.* the East, West, North, and South. But

Secondly, If any such Perpendicular Plain do stand in any other Azimuth or Vertical-Circle between the South and the East, or the North and the West, so that one Face beholdeth the South-East, and its opposite the North-West; then these Plains are called Vertical Planes Declining from the North or South, towards either the East or West.

3. Of Plains that cut the Horizon at Oblique Angles, and yet do lie directly in the prime Vertical Circle, or Azimuth of East or West, there are six Varieties. For,

First, A Plain beholding the South, may fall back, (or Recline) from the Zenith, just into the Pole, and then will the Plain lie Parallel to the Axis of the World, and such a Plain is called, a *Polar Plane*.

Secondly, It may so fall back (or Recline) from the Zenith, that it may fall between the Zenith and the Pole, or between the Pole and the Horizon; and these three sorts are called South Reclining Plains.

Reclining  $\left\{ \begin{array}{l} \text{equal to} \\ \text{less than} \\ \text{more than} \end{array} \right\} \text{the Pole or Co-Latitude of the Place.}$

Thirdly, A Plain beholding the North, may fall back (or Recline) from the Zenith equal to the Equinoctial, and so the Plane will lie Parallel to

to the Equinoctial Circle, and is therefore called an Equinoctial Plain.

Fourthly, It may so fall back (or Recline) that it shall rest between the Zenith and the Equinoctial, or between the Equinoctial and the Horizon; and these three sorts are called North Reclining Plains.

Reclining  $\left\{ \begin{array}{l} \text{equal to} \\ \text{less than} \\ \text{more than} \end{array} \right\} \begin{array}{l} \text{the Equinoctial,} \\ \text{or Latitude of} \\ \text{the Place.} \end{array}$

Fifthly, Of Plains that cut the Horizon at Oblique Angles, and do lie directly in the Meridian or Azimuth of North and South, there is only one Variety: For all such Planes will fall between the Zenith, and the East or West-points of the Horizon; and so are called East or West Recliners.

Sixthly, Of Plains that cut the Horizon at Oblique Angles, and do not lie in the prime Vertical-Circle or Azimuth of East and West, but in some other intermediate Azimuth or Vertical-Circle between the South and the East or West; there are also six Varieties:— And of these, those that behold the South, are called South-Recliners, declining East or West:— And those that behold the North, are called North-Recliners, declining either East or West; and of these there are six Varieties.

Now of these six sorts, all Plains besides the forementioned must necessarily be one of these following: For,

1. The

1. The South Re-  
clining Plain, by  
reason of its De-  
clination, may so  
chance as to fall

Just into the Pole-point, and so is called  
a Polar declining Plain.  
Between the Zenith and the Pole.  
Between the Pole and the Horizon.

And these are called South Declining Plains.

Reclining  $\left\{ \begin{array}{l} \text{equal to} \\ \text{less than} \\ \text{more than} \end{array} \right\}$  the Pole.

2. The North Re-  
clining Plain, by  
reason of its De-  
clination, may so  
chance as to fall

Just at the Intersection of the Meridian  
with the Equinoctial.  
Between the Zenith and Equinoctial.  
Between the Horizon and the Equi-  
noctial.

And these are called North Declining Plains.

Reclining  $\left\{ \begin{array}{l} \text{equal to} \\ \text{less than} \\ \text{more than} \end{array} \right\}$  the Equinoctial.

Seventhly, All Plains that do Decline and Re-  
cline also, have their opposite Faces, and those  
are called North or South Declining Inclining  
Plains; and the same Dial that serves for a South  
Declining Reclining Plain, will serve also for a  
North Declining Inclining Plain.

And Dials upon any of these Variety of Planes  
may be made by the Globes, as I shall come now  
to shew.

P R O B. I.

*To make an Horizontal Dial in any Latitude.*

I. *By the Globe.*

**E**levate the Globe to the Latitude of the place for which you would make your Dial, (suppose for *London*, in the Latitude of 51 deg. 30 min.) Then bring the Vernal Equinoctial Colure (which is the first point of *Aries*) also to the Meridian, and (if you will) the Index of the Hour-Circle to 12. This done,

1. Turn the Globe about Westward, till the Hour-Index points at 1 a Clock, or rather [till 15 degrees of the Equinoctial come to be just under the Meridian,] and there

Latitude 51 30		
		d. m.
12		00 00
11	1	11 50
10	2	24 20
9	3	38 3
8	4	53 35
7	5	71 6
6		90 0

keeping the Globe, look upon the Horizon how many Degrees thereof are cut by the Equinoctial Colure; which you shall find to be 11 deg. 50 min. which set down in a little Table, as you see here is done; for this 11 deg. 50 min. the Hour-Lines of 11 and 1 a clock are distant from the Meridian upon the Dial Plain.

2. Turn the Globe more Westward, till 30 deg. of the Equinoctial comes to the Meridian, and then see what Degrees of the Horizon are cut by the Equinoctial Colure; which you will find to be 24 deg. 20 min. which note down in a Table as before, for that is the Hour-distance of 10 and 2 a Clock from the Meridian.      K      3. Turn

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3. Turn the Globe still more Westward, till 45 degrees of the Equinoctial come to the Meridian, and then shall the Equinoctial Colure cut 38 deg. 3 min. of the Horizon counted from the Meridian, which is the distance of 9 and 3 a Clock.

Do thus with the other Hours of 8 and 4, of 7 and 5, and so shall the Colure cut 90 degrees at 6 a Clock, or when 90 degrees of the Equinoctial comes to the Meridian. And this being done, your Dial is so far made as the Globe can assist you. Now for

### II. *The Geometrical Construction of this Dial.*

#### F I G. I.

1. Upon the Plain on which you design to draw your Dial, draw a Right Line A B, representing the Meridian of your Globe, and the Hour-Line of 12 of the Clock.

2. Assign towards one end of this Line a point as C, representing the Centre of your Dial, and through that Point draw another Line at Right Angles to A B, which shall be the Hour-Line of 6 a Clock, as the Line H K; and upon the Point C, describe a Semicircle D E F, according to the Radius of some Line of Chords. Then

1. Laying your little Table (before made) before you, you find Latitude 51 deg. 30 min. Take 51 deg. 30 min. from your Line of Chords, and set that distance upon the Semicircle from E to G, and draw the Line C G for the Style or Cock of your Dial.

2. Then



2. Then seeing that 11 and 1 a clock, are distant from the Meridian 11 deg. 50 min. take 11 deg. 50 min. from your Chord, and set it upon the Semicircle from E to 11, and from E to 1, and draw the Lines C 11, and C 1, for the Hour-Lines of 11 and 1.

3. The distance of 10 and 2 a clock being 24 deg. 20 min. take 24 deg. 20 min. out of your Line of Chords, and set it upon the Semicircle from E to 10, and from E to 2, and draw the Lines C 10, and C 2, for the Hour-Lines of 10 and 2.

4. Do thus with the rest of the Hour-Lines of 9 and 3, 8 and 4, ——— 7 and 5. So have you all the Hour-Lines between 6 in the morning and 6 at night; and for the Hour-Lines of 4 and 5 in the morning, and of 7 and 8 at night, draw the same Hour-Lines before 6 through the Centre, as in the Figure, and they shall be the true Hour-Lines: And so is your Dial finished.

The Style must stand upright upon 12 of the clock, not inclining on either side.

## P R O B. II.

*To make a Vertical South Dial.*

### *I. The Operation by the Globe.*

**T**He Globe being set to the Latitude, and the Quadrant of Altitude in the Zenith,

1. Bring the Equinoctial Colure to the Meridian, and (if you will) the Index of the Hour-Wheel to 12.

R 2

2. Turn

Compl. of the Latit. 38. d. 30. m.		d. m.
12		00 00
11	1	9 28
10	2	19 45
9	3	31 54
8	4	47 9
7	5	66 42
6		90 00

2. Turn the Globe about Westward, till 15 Degrees of the Equinoctial be under the Meridian, then shall the Equinoctial Colure cut 9 deg. 28 minutes of the Horizon counted from the Meridian; and that is the Hour-distance of 11 and 1 a clock from 12.

3. Turn the Globe more Westerly, till 30 d. of the Equinoct. be under the Meridian; then shall the Colure cut up-

on the Horizon 19 deg. 45 min. which is the distance of 10 and 2 a clock from 12.

4. Turn the Globe still Westerly, till 45 deg. 60 deg. and 75 deg. come under the Meridian; and so shall you find that the Colure will cut the Horizon in 31 deg. 54 min. for 9 and 3 a clock, and the rest, as in this Table. And so is the Globular work of your Dial finished.

## II. *The Geometrical Construction of this Dial.*

### FIG. II.

1. Draw a Right Line L M upon your Plain for the Meridian, and Hour-Line of 12; and another Perpendicular thereto, as N P for the Hour-Line of 6 and 6; and where these Lines cross (as at O,) is the Center of your Dial.

2. Upon O, as a Centre, with the Radius of a Line of Chords, describe a Semicircle N Q P, and then taking 38 deg. 30 min. (which is the Complement of the Latitude of the place) out of the Line of Chords, set it from Q to R, and draw

draw the Line O R for the Cock or Style of your Dial.

3. Laying your Table before you, against 11 and 1 of the clock, you find 9 deg. 28 min. Take therefore 9 deg. 28 min. out of your Chord, and set that distance upon the Semicircle from Q to 11, and from Q to 1, and draw the Lines O 11 and O 1, for the Hour-Lines of 11 and 1.

4. Also take 19 deg. 45 min. and set them from Q to 10, and from Q to 2, and draw O 10, and O 2, for the Hours of 10 and 2.

5. Do the like for the Hours of 9 and 3, 8 and 4, 7 and 5, and your Dial is finished.

The Style must stand over 12, and must point downwards towards the South-Pole at the Elevation.

### P R O B. III.

*To make a Vertical direct North-Dial.*

**T**He North Vertical Dial, is the same with the South, only the Style must point upwards towards the North-Pole, and the Hours about midnight, as 9. 10. 11. 12. at midnight, and 1. 2. 3. in the morning, must be left out, and 4 and 5 in the morning; and 7 and 8 at night must be drawn through the Center: So is your North-Dial also finished.

## P R O B. IV.

*To make a direct Vertical East or West Dial.*I. *The Operation by the Globe.*

**T**He Globe rectified to the Latitude, the Index to 12, the Quadrant of Altitude in the Zenith : If you turn the Quadrant of Altitude so about, till the graduated Edge thereof do behold the direct East or West Points of the Horizon, you shall find that it will lie in the very Plain of the Meridian-Circle, and so the Pole will have no Elevation over it ; for turning the Globe about, the Equinoctial Colure will not cut the Quadrant of Altitude in any particular degree, but it will cut all the degrees thereof at the same time ; wherefore the Hour-Lines of these Plains will make no Angles at the Pole, and therefore must be Parallel one to the other, which the Globe evidently demonstrates, but will not conveniently give the Parallel distance of each from the other, they being nearer or farther off of each other according as the Style is proportioned to the Plain, which I shall now come to shew in

II. *The Geometrical Construction of these Dials.*

## F I G. III.

Let the Plain upon which you would make an East or West Dial, be A B C D.

1. Upon D (or any where towards the lower part of the Line B D, for an East Dial, or of A C for a West) with 60 degrees of your Chord, describe

scribe an Arch F G, upon which set the Complement of the Latitude of the place, viz. 38 deg. 30 min. from F to G, and draw the Line D G E for the Equinoctial.

2. Towards the upper part of this Line, as at P, assume any point, and through it draw the Line 6 P 6 perpendicular to the Equinoctial, for the Hour-Line of 6. ——— Also, towards the lower part of the same Line, assume another point, as L, and through it draw the Line 11 C 11 for the Hour-Line of Eleven.

3. With 60 deg. of your Chord, upon the point C, describe a small Arch of a Circle, as H K, and upon it (always) set 15 deg. (or one hours distance) from H to K, and draw the Line K C M, cutting the Hour-Line of 6 in M.

4. Upon M as a Center, with 60 degrees of your Chord, describe an Arch of a Circle N O, which divide into five equal parts in the points ☉ ☉ ☉ ☉.

5. Lay a Ruler upon M, and each of these points ☉ ☉ ☉ ☉, and the Ruler will cut the Equinoctial-Line E D in the points \* \* \* \*, through which points, if you draw Right Lines parallel to the Hour-Line of 6, they shall be the Hour-Lines of 7, 8, 9, and 10 of the clock, the Hour-Lines of 6 and 11 being drawn before.

6. For the Hour-Lines of 4 and 5 in the morning, before 6, they retain the same distance from 6, as do the Hours of 7 and 8; and thus is your Dial finished.

The Style must stand upon the Hour-Line of 6, and be elevated so high as is the length of the Line M P, and may either be a pin of Wyre, or a plate of Brass or Iron.



The West Dial is the same with the East, only changing the Names of the Hours.

4, 5, 6, 7, 8, 9, 10, 11 in the morning, in the East-Dial;

Must be changed to  
8, 7, 6, 5, 4, 3, 2, 1 in the afternoon, in the West-Dial:

Which is all the difference.

### P R O B. V.

*To make a Vertical Dial declining from the South, Eastward, or Westward 30 deg. in the Latitude of 51 deg. 30 min.*

#### I. *The Operation by the Globe.*

**T**HE Globe being Rectified to the Latitude of the place, the Quadrant of Altitude in the Zenith, the Index of the Hour-Circle at 12, and the Equinoctial Colure brought under the Meridian;

1. Count the Declination of the Plain upon the Horizon, from the East or West-points thereof (according as the Plain declines) towards the South: namely, 30 deg. and to that point of the Horizon bring the Quadrant of Altitude, and there keep it.

2. Turn the Globe about, till the Index of the Hour-Wheel cuts 11 of the clock, or rather (as I said before) till 15 deg. of the Equinoctial have passed the Meridian, and then shall you find the Equinoctial Colure to cut the Quadrant of Altitude

tude at 9 deg. 50 min. if you count the degrees from the Zenith point downwards.

3. Turn the Globe farther about, till 30 deg. of the Equinoctial be past the Meridian, and then shall you find the Colure to cut the Quadrant of Altitude at 18 deg. 14 min. counted from the Zenith downwards as before.

4. Do the like with all the rest of the hours, and you shall find that at the several 15 deg. of the Equinoctial, the Equinoctial Colure will cut such degrees of the Quadrant of Altitude as are expressed in this Table, if you count them from the Zenith downwards, as is before directed.

Hours from Noon.		Hour-distan- on the Plain.	
		d.	m.
	12	00	00
11	1	09	50
10	2	18	14
9	3	26	19
8	4	34	56
7	5	44	56
6	6	57	49
5	7	75	37

This done;

5. Bring the Quadrant of Altitude to the other side of the Meridian, and set it to 30 deg. the Plains Declination, counted from the East or West-points Northward, as you did before towards the South, which will be in the just opposite point of the Horizon to which it was before; and also, bring the Equinoctial Colure under the Meridian. Then,

6. Turn the Globe about (the contrary way to what you did before) till 15 degrees of the Equinoctial be past the Meridian, and then shall you find the Equinoctial Colure to cut at 12 deg. 23 min. of the Quadrant of Altitude counted from the Zenith.

And

Hours from Noon.	Hour- distan. on the Plain.
	d. m.
12	00 00
1 11	12 23
2 10	29 19
3 9	52 42
4 8	80 07

And so continuing turning the Globe about till 30, 45, and 60 degrees of the Equinoctial have passed the Meridian, you shall find the Equinoctial Colure to cut the Quadrant of Altitude, at such degrees as are expressed in this Table.

The Hour-distances upon the Plain being thus attained, there are two other Requi-

sites in all upright declining Dials also to be found by the Globe, before the Dial can be finished. Namely,

1. The distance of the Substyle from the Meridian.
2. The height of the Pole above the Plain, or the height of the Style above the Substyle.

To find both which,

Bring the Equinoctial Colure to the Plain's Declination 30 deg. counted upon the Horizon from the South Eastward; and the Quadrant of Altitude to 30 deg. counted in the Horizon from the East-Northward: So shall the Quadrant cut the Colure at Right Angles. And

The number of degrees of the Quadrant, contained between this Intersection and the Zenith (which here is 21 deg. 41 min.) is the distance of the Substyle from the Meridian. And the degrees of the Colure contained between this Intersection and the Pole (which here is 32 deg. 37 min.) is the height of the Pole above the Plain.

*II. The*

II. *The Geometrical Construction.*

F I G. IV.

1. Draw a Line C D for the Meridian and Hour-Line of 12, and at Right Angles thereunto draw another Line, as A B, for the Horizontal-Line, crossing the former in the point C, the Center of the Dial.

2. Upon the point C, describe the Semicircle A G B.

3. Take 21 deg. 41 min. from your Chord, and (because the Plain declines Eastward) set it from G to E; also, take from your Chord 32 deg. 37 min. (which is the height of the Pole above the Plain) and set it from E to F, and draw the Line C E for the Substyle, and C F for the Style of the Dial.

4. Having recourse to the Tables of Hour-distances, take 9 deg. 50 min. and set it from G to 11; also take 18 deg. 14 min. and set it from G to 10, and so the rest in that Table. — Also out of the other Table take 12 deg. 23 min. and set them from G to 1, &c.

5. From the Center C draw Lines through the several points 5, 6, 7, 8, 9, 10, and 11; and also through 1, 2, 3, and 4, they shall be the true Hour Lines; and so have you finished this Dial.

And in the making of this Dial, you have made four Dials; as I have intimated at large in my *Art of Dialling*, Part 1. Chap. 7. For,

If you hold the Paper upon which the South-East Declining Dial is drawn, against the light, then shall you discover the Style to stand on the Right hand of the Plain, whereas it now stands on



on the Left hand ; so the same Hour-Lines, Substyle, Style and all, being drawn on the back-side of the Paper, and those that are the Forenoon-hours in the East Decliner, numbred as the Afternoon-hours in the West-Decliner, that is, call 11, 1, and 10, 2, and 9, 3, &c. as in the Tables ; so shall the South-Dial declining Eastward 30 deg. become a South-Dial declining Westward 30 degrees.

And if you turn the South-East-Dial upside-down, so that the Style may point upwards towards the North-Pole, (and leave out the hours about 12, as 9, 10, 11, and 1, 2, and 3, which in North Dials represent 9, 10, and 11 at night, and 1, 2, and 3 in the morning ; all which time (in those middle Latitudes) the Sun is under the Horizon) it will become a North-Dial declining Eastward 30 degrees.

Also if you turn the South Declining West-Dial upside-down, and leave out the hours about Midnight, as 9, 10, 11, 12, 1, 2, and 3, it will then become a North-Dial declining Westward 30 degrees.

Now for such South or North-Dials as do decline far towards the East or West, as 60, 70, 80, or 85 degrees, there you shall find that the Hour-distances will fall so near together, that they will be of no competent distance one from another, except they be extended very far from the Center ; and therefore the old way hath been (in such Cases) to draw the Dial upon the Floor of a Room, extending the Substyle, Style, and Hour-Lines till they appear of a competent distance from each other, and then according to the bigness of your Dial-plain, to cut off the Hour-Lines, Stile, and Substile, and  
so



so transfer them from the Floor, to the Plain upon which the Dial is to be made: but this way being too Mechanical for an Artist to Exercise, I have in my foresaid Art of Dialling, shewed a more artificial way of performing this work Geometrically, by which although the Dial should decline 80 or 88 degree ) upon a quarter of a Sheet of Paper you may draw your Dial, and have the Stile of a competent height, and all the Hour-Lines at a convenient distance one from another. And so let this suffice to be said in this place concerning Upright Declining Dials; for I intend not here to teach the Art of Dialling, but shew the Use of the Globes.

P R O B. VI.

*Of direct South Reclining Dials.*

**T**O find the distances of the Hour-Lines upon these Plains by the Globes, this is the natural way.

*The Operation by the Globe.*

Having set the Globe to the Latitude, the Index of the Hour-Circle to 12, the Quadrant of Altitude to the Reclination, with the end thereof in the East or West points of the Horizon, and brought the Equinoctial Colure to the Meridian.— Turn the Globe about, till the 1 Hour, or 15 degrees of the Equinoctial hath passed the Meridian, and then see what degrees of the Quadrant of Altitude are cut by the Equinoctial Colure; for those degrees counted from the upper part of the Quadrant downwards, are the

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are the degrees of the first Hours distance (as of XI or I of the clock) from the Meridian of XII a clock, and so for all the rest of the Hour-distances.

This I say is the Natural way ; but the more Artificial and better way, will be to refer such Reclining Plains to a New Latitude where they may become Horizontal Plains ; and that may be easily effected, as I shall presently shew.

I formerly said, that a South-Plain may so recline, that the Reclination thereof may be either,

Less than }  
 Equal to } the Comple. of the known Latitude.  
 more than }

Now to refer any of these Plains to a new Latitude, where they may become Horizontal Plains, observe,

1. If the Reclination of the Plain be less than the Complement of the known Latitude, Subtract the Plains Reclination from the Complement of the Latitude, and the Remainder shall be a New Latitude, where the Reclining Plain shall be an Horizontal Plain ; and, in this Case, the South-Pole (in North-Latitudes) is always elevated.

2. If the Reclination be equal to the Complement of the known Latitude, then the New Latitude is no Latitude ; for the Plain lies in the very Axis of the World, and hath neither Pole elevated above it.

3. If

3. If the Reclination of the Plain be more (or Greater) than the Complement of the known Latitude, Subtract the Complement of the known Latitude from the Plains Reclination, and the Remainder shall be the New Latitude; and in this Case, the North-Pole (in North-Latitudes) is always elevated.

*Examples of these three Varieties.*

I. *Of a South Plain, Reclining less than the Complement of the Latitude.*

**L** Et a South-Plain in the Latitude of 51 degrees 30 min. North, recline 20 degrees : Now because 20 degrees is less than 38 degrees 30 minutes, the Complement of the known Latitude, subtract 20 degrees from 38 degrees, 30 minutes, and there remain 18 degrees 30 minutes, which will be the New Latitude. Wherefore if you Rectifie the Globe to 18 degrees 30 minutes of Latitude, and make an Horizontal Dial as is before taught in all respects, that Dial shall serve for a South-Dial reclining 20 degrees in the Latitude of 51 degrees 30 minntes, the Hour-

		d.	m.
Latitude		51	30
South recl.		20	00
New Latit.		18	30
Hours		Hour-distances.	
		d.	m.
12		00	00
11	1	04	52
10	2	10	23
9	3	17	36
8	4	28	48
7	5	49	50
6		90	00

distances

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distances being such as are expressed in this Table, and the height of the Style above the 12 a Clock-Line (or Substyle) to be equal to the New Latitude, namely, 18 degrees 30 min.

II. *Of a South Plain Reclining equal to the Complement of the Latitude.*

Thus if a South Plain in the Latitude of 51 degrees 30 minutes, shall recline 38 degrees 30 minutes, equal to the Complement of the Latitude, the New Latitude (as is said before) shall be no Latitude, and so neither Pole have any Elevation; wherefore the Dial is to be made in all respects as an East or West-Dial is made, only that Hour-Line which in the East or West-Dial is the six a Clock Hour-Line, must in these Dials be the Hour-Line of 12, &c.

III. *Of a South Plain Reclining more than the Complement of the Latitude.*

Suppose a South Plain in the Latitude of 51 degrees 30 minutes should Recline from the Zenith 60 degrees; forasmuch as 60 degrees is more than 38 degrees 30 minutes, the Complement of the known Latitude, subtract 38 degrees 30 minutes from 60 degrees, and the remainder 21 degrees 30 minutes will be the New Latitude.

Wherefore,



Wherefore, if you make an Horizontal Dial for the Latitude of 21 deg. 30 min. you shall find the Hour-distances to be such as are expressed in this Table, and shall serve for a South-Dial Reclining from the Zenith 60 degrees in the Latitude of 51 degrees 30 minutes. And the Style of this Dial must be Elevated above the Substyle ( or Hour-Line of 12 ) 21 degrees 30 minutes equal to the New Latitude, and must point upwards towards the North-Pole ; as must the Styles of all South-Plains which Recline more than the Complement of the Latitude.

		d.	m.
Latitude		51	30
South recl.		60	00
New Latit.		21	30

Hours		Hour-distances.	
		d.	m.
12		00	00
11	1	05	37
10	2	11	57
9	3	20	08
8	4	32	25
7	5	53	50
6		90	00

P R O B. VII.

*Of North Reclining Dials.*

**T**He Natural way of finding of the Hour-distances for North Reclining Dials is thus.

*The Operation by the Globe.*

Rectifie the Globe to the Latitude, set the Quadrant of Altitude to the Reclination, and the end of it to the East or West-points of the Horizon, the Index of the Hour-Circle to 12, and the Equi-

L

noctial



noctial Colure to the Meridian—— Then turn the Globe about till 15 degrees of the Equinoctial have passed the Meridian, and then see what degrees of the Quadrant of Altitude are cut by the Equinoctial Colure; for those degrees (counted from the upper end of the Quadrant of Altitude) are the first Hours distance from 12, as of 11 and 1 of the Clock: and so of all the rest of the Hours.

This is the Natural way; but the better way will be to refer these North Reclining Plains to a New Latitude, as before you did the South-Recliners.

Of these North Reclining Plains, there are Three Varieties, as there were of the South-Recliners: for the Reclination may be either

$$\left. \begin{array}{l} \text{less than} \\ \text{equal to} \\ \text{more than} \end{array} \right\} \text{the Latitude of the Place.}$$

And to refer these to a New Latitude, where there will be Horizontal Plains, you must observe,

1. If the Reclination of the Plain be less than the Latitude, add the Complement of the Latitude to the Plain's Reclination, and the sum shall be the New Latitude, and the North-Pole (in North-Latitudes) shall be always elevated.

2. If the Reclination be equal to the Latitude, add the Complement of the Latitude and the Reclination together, and the sum shall be the New Latitude, which in this Case will always be 90 degrees.

3. If the Reclination be more than the Latitude, add the Reclination of the Plain, and the Complement

plement of the Latitude together, the sum of them shall be the New Latitude, and the North-Pole shall always be elevated. But if the Sum exceed 90 degrees, the Complement thereof to 180 degrees is the New Latitude.

*Examples of these three Varieties.*

*I. Of a North-Plain Reclining less than the Latitude.*

**L**et a North-Plain in the Latitude of 51 deg. 30 min. recline from the Zenith 20 deg. add 20 degrees (the Reclination) to 38 deg. 30 min. (the Complement of the Latitude) the sum will be 58 deg. 30 min. which is the New Latitude.

Wherefore, if you rectifie the Globe to 58 deg. 30 min. of Latitude, and make an Horizontal Dial as is before taught, you shall find the Hour-distances to be such as are expressed in this Table. And the Style must be elevated above the Substyle (or Hour-Line of 12) equal to the New Latitude; and so shall this Horizontal Dial, made for the Latitude of 58 deg. 30 min. serve for a North-Dial Reclining 20 degrees in the Latitude of 51 d. 30 m.

		d.	m.
Latitude		51	30
North recl.		20	00
New Latit.		58	30
Hours		Hour-distances.	
		d.	m.
12		00	00
11	1	12	52
10	2	26	12
9	3	40	22
8	4	55	50
7	5	72	33
	6	50	00

II. *Of a North-Plain Reclining equal to the Latitude.*

Let a North-Plain in the Latitude of *London* 51 deg. 30 min. recline from the Zenith 51 deg. 30 min. this added to the Complement of the Latitude, *viz.* 38 deg. 30 min. the sum will be 90. so that 90 deg. is the New Latitude. Wherefore, rectifie the Globe to 90 deg. of Latitude, so shall the Pole be in the Zenith, and the Equinoctial in the Horizon: then turn the Globe about till 15 deg. of the Equinoctial Colure have passed the Meridian, and it will rest at 15 deg. of the Horizon, which is the first Hours distance from 12. for in these Plains the degrees of the Equinoctial and the degrees of the Horizon being the same, there is no more in the making of this Dial, than to divide a Circle into 24 equal parts, and (being the New Latitude is 90 deg.) erect a Wire perpendicularly in the Center, and the Dial is finished.

III. *Of a North-Plain Reclining more than the Latitude.*

Suppose that in the Latitude of 51 deg. 30 min. a North-Plain should recline from the Zenith 75 deg. add 75 deg. the Reclination of the Plain to 38 deg. 30 min. the Complement of the Latitude, the sum of them is 113 deg. 30 min. the Complement whereof to 180 deg. is 66 deg. 30 min: which is the New Latitude.

Wherefore,



Wherefore, rectifie the Globe to the Latitude of 66 deg. 30 min. and (according to former directions) make an Horizontal Dial for that Latitude, and you shall find the Hour-distances to be such as are expressed in this Table; and such an Horizontal Dial for the Latitude of 66 deg. 30 min. shall serve for a North-Dial reclining 75 deg. in the Latitude of 51 deg. 30 min. The Stile must be elevated above the 12 a Clock Hour-Line equal to the New Latitude, namely, 66 deg. 30 min.

		d.	m.
Latitude		51	30
North recl.		75	00
New Latit.		66	30

Hours		Hour-distances.	
		d.	m.
12		00	00
11	1	13	48
10	2	27	54
9	3	42	32
8	4	57	48
7	5	73	43
6		90	00

P R O B. VIII.

*Of East or West direct Recliners.*

**S**uch Plains as lie in the Meridian or Azimuth of North and South, and do recline from the Zenith towards the East or West-points of the Horizon, are called East or West-Recliners; and the Natural way of finding of the Hour-distances upon these Plains by the Globes, is thus.

I. *The Operation by the Globe.*

The Globe rectified to the Latitude of the place, the Quadrant of Altitude in the Zenith, the Equinoctial

noctial Colure brought to the Meridian, the Index of the Hour-wheel to 12, and the Semicircle of Position fixed to the Meridian in the North and South-points of the Horizon, elevate the Semicircle of Position to the Complement of the Plain's Reclination, counted upon the Quadrant of Altitude from the Horizon; then move the Globe about, till the Equinoctial Colure hath passed 15 deg. of the Equinoctial, and then the degrees of the Semicircle of Position, cut by the Equinoctial Colure (counted from the Meridian) shall be the degrees that the first Hour-Line of 11 or 1 shall be distant from the Meridian, or Hour-Line of 12.—Also turn the Globe about till the Equinoctial Colure hath passed 30 deg. of the Equinoctial Circle, and the degrees cut by the Colure upon the Semicircle of Position shall be the degrees that the second Hour-Line shall be distant from 12, &c.

This is the Natural way of making of these Dials by the Globe; but (to retain our former method) we will refer these East or West Reclining Dials to a New Latitude, where they shall be upright declining Plains; which to perform, is easie: For,

In all East or West-Recliners, the New Latitude is always the Complement of the known Latitude, and the New Declination is always the Complement of the Reclination; so that an East or West-Plain in the Latitude of 51 deg. 30 min. reclining 40 deg. will be an upright North-Plain declining East or West 50 deg. in the Latitude of 38 deg. 30 min. for 38 deg. 30 min. is the New Latitude, it being the Complement of the known Latitude, and 50 deg. is the New Declination, it being the Complement of the Plain's Reclination in the known Latitude; wherefore, if (according to



to the directions given you in the Fifth Problem) you make an upright Dial, declining 50 deg. for the Latitude of 38 deg.

30 min. you shall find all the Hour-distances to be such as are expressed in this Table. The distance of the Substyle from the Meridian to be 43 deg. 55 m. and the height of the Pole or Style above the Plain or Substyle, to be 30 deg. 12 m. which declining Dial in this New Latitude, shall be an E. or W. Reclining Dial in the known Latitude.

But in the placing of the Dial upon the Reclining Plain, there is this difference: For whereas in all upright Declining Plains, the Meridian or Hour-line of 12 is Perpendicular to the Horizon, in all East or West-Recliners the Meridian (or Hour-Line of 12) must lie parallel to the Horizon. And here

note also, That all East-Recliners in the known Latitude, are N. E. Decliners in the New Latitude, and all West-Recliners are N. W. Decliners. All which may be seen in

		d.	m.
East Reclining	40	00	
Latitude	51	30	
New Latitude		38	30
Declination	50	00	
Distance of	Substyle from Meridian	43 55	
Stiles height			
	30	12	
Hours from Noon.	Hour-distances on the Plain.		
	d.	m.	
12	00	00	
1 11	15	14	
2 10	26	12	
3 9	34	57	
4 8	42	42	
5 7	50	21	
6 6	58	39	
7 5	68	43	
8 4	82	18	
11 1	22	09	
10 2	48	43	
9 3	75	52	

## FIG. V.

And note farther, That upon all East and West Recliners (how far soever) in North-Latitudes, the North-Pole is always elevated; and upon the East and West-Incliners opposite to them, the South-Pole.

Thus have you the manner of making of all sorts of direct Reclining or Inclining Dials by the Globes two several ways; namely, by the Natural way, as they lie in respect of the Horizon, where they are to be placed Obliquely: And also a more Artificial way, by referring them to New Latitudes and New Declinations, where they may become Horizontal or Upright Declining Plains. And now let us proceed to

## P R O B. IX.

*Of Declining, Reclining, or Inclining Plains.*

**S**uch Plains as do not directly behold the East, West, North, or South-Points of the Horizon, nor do stand Perpendicular thereunto, but fall back from the Zenith, these Plains are called North or South-Recliners. For the making of these kinds of Dials by the Globes, the Natural way followeth.

*I. The Operation by the Globe.*

For our Example, Let us suppose a Plain in the Latitude of 51 deg. 30 min. to decline from the North-part of the Meridian towards the West 72 deg. and also to Recline from the Zenith 26 deg. 34 min.

1. Elevate

1. Elevate your Globe to the Latitude of the place 51 deg. 30 min. the Quadrant of Altitude in the Zenith, the Hour-Circle to 12, and the Equinoctial Colure to the Meridian.

2. The Declination being 72 deg. Westward, count upon the Horizon 20 deg. (the Complement thereof, from the South-part of the Meridian Westward, and from the North-part of the Meridian Eastward; and to these two Points in the Horizon, bring the two extream ends of your Circle of Position, (or which is far better, a narrow Plate of thin Brass, containing a compleat Semicircle at least, divided into degrees as the Quadrant of Altitude is, beginning the divisions at the middle, and numbering them both ways towards the ends) and there fix it. Then bring the Quadrant of Altitude to 20 deg. in the Horizon, counted from the East Southward— Now (because the Plain Reclines 26 deg. 34 min.) count those degrees upon the Quadrant downwards, from the Pole, and to that Point bring down the thin Plate of Brass, representing your Plain, and there fix it; for now is your Globe prepared for the making of your Dial. And,

*1. For the Hour-distances:*

If you turn the Globe about Eastward, till 15 deg. of the Equinoctial have passed the Meridian, you shall find upon the Plain intercepted between the Colure and the Meridian 26 deg. 3 min. which is the first Hours distance from 12 upon your Plain. Again, turn the Globe about still Eastward, and you shall find 44 deg. 30 min. intercepted, which is the second Hours distance upon the Plain.

Also, if you turn about the Globe Westward till 15 deg. of the Equinoctial have passed the Meridian,



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dian, there will be cut by the Colure upon the Plain, 28 deg. 4 min. which is the first Hours distance on the other side of the Meridian. And so do with all the rest, and you shall find them as in this following Table.

	d.	m.
North declining	72	00
Reclining	26	34
Distance between the Meridian and Horizon	36	00
Distance between the Plain and Zenith	58	17
Height of the Pole above the Plain	31	28
Distance of the Substyle and Meridian	82	04
	d.	m.
12	00	00
1 11	26	03
2 10	44	30
3 9	57	47
4 8	67	53
5 7	76	12
Substile	Substile	
6 6	84	15
7 5	87	38
8 4	78	25
9 3	66	48
10 1	50	46
11 1	28	04

Now

Now (besides these Hour-distances) there must be Four other things found before we come to the Geometrical Construction of this Dial; and those are,

1. *The Arch of the Plain (or the distance) between the Meridian and Horizon*, and that may be found thus.—— Take with your Compasses (or with a thin Plate of Brass or Horn divided) the Distance upon the Plain, from the Intersection of the Plain with the Horizon, to the Intersection of the Plain with the Meridian; and those degrees, namely 36, are the Distance required.

2. *The Arch of the Meridian between the Plain and the Zenith*. The which may be thus found. For the degrees of the Meridian intercepted between the Plain and the Zenith, viz. 58 d. 17 m. is this Arch.

3. *The height of the Pole or Style above the Plain*.—— And to find this, You must continue your Quadrant of Altitude from the Zenith below the Horizon, so much as is the Reclination of the Plain, 26 deg. 34 min. And mark that Point, for it is the Pole of the Reclining Plain. Then a thin Plate of Brass, (for the Quadrant of Altitude will be (for the most part) too short) divided, being extended from the North-Pole towards the South-Pole, and passing through the Pole of the Plain, (which is the Point before found) mark where the Plate cutteth the Plain; and the number of degrees of the Plate that are contained between the Pole and the Plain, which will be here found 31 deg. 28 min.  
is



is the height of the Pole or Style above the Plain or Substile.

4. *The distance of the Substyle from the Meridian.* — And that is, the number of degrees of the Plate representing the Plain, which are contained between the Plate which came from the Pole of the World to the Pole of the Plain, and the Intersection of the Plain with the Meridian, which in this *Example* will be found to be 82 degrees 4 minutes.

## II. *The Geometrical Construction of this Dial.*

### F I G. VI.

1. Upon the Plain upon which you intend to describe your Dial, draw an Horizontal-Line thereupon, as A B; and another Perpendicular thereunto D G, for the Vertical-Line of your Plain, cutting the former A B in the point C, which point C make the Center of your Dial.

2. Upon the Center C, with 60 degrees of a Line of *Chords* describe a Circle, as A F B G, then take 36 deg. (*the distance of the Meridian from the Horizon,*) and set it from A to 12 downwards, and from B to 12 upwards, and draw the Line 12 C 12 for the Hour-Line of XII.

3. Take 82 deg. 4 min. (*the distance of the Substyle from the Meridian*) and set them from 12 upwards to G on the Left Hand, and downwards from 12 to G on the Right Hand, drawing the Line G C G through the Center, for the Substylar-Line of both the Dials: — And the height of the Pole or Style above the Plain being 31 deg. 28 min. set those degrees from G to H, both

both above and below, and draw the Line H C H quite through the Center, for the Axis or Styles of both Dials.

4. Laying your Table of Hour-distances before you, and there finding the first Hours distance from 12 is 26 deg. 3 min. set that distance upon the Circle from 12 upwards to 1, and from 12 (on the other side) downwards to 11, and draw the Lines C 1, and C 11, for the Hour-Lines of 11 and 1 a Clock, which will both be but one streight Line.

Do thus with all the Hours in the Table till you come to the Substyle, and then, (beginning at the bottom of the Table)

5. Take 28 deg. 4 min. and set them from 12 on the Right Hand downwards to 11, and from 12 on the Left Hand upwards to 1, and draw the Line C 11 in the North Reclining Plain, for the Sun will never shine upon the South Inclining Plain at 1, otherwise you should have drawn it through the Center as you did before. Do the like with all the rest of the Hours, drawing such through the Center as you find occasion for; which the sight of the Figure will inform you how to do, better than many Words.

Lastly, Erect your Style Perpendicular to your Substyle, making an Angle therewith equal to the Elevation thereof; namely, 31 deg. 28 min. and your Dials are finished.—— And in the making of these, you have made two others also, *viz.* A North Declining 72 deg. Eastward, and Inclining 26 deg. 34 min. and a South Declining Westward 72 deg. and Inclining as the other; all which is done (and may easily be apprehended by any Person)

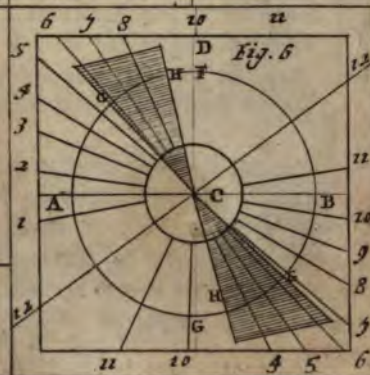
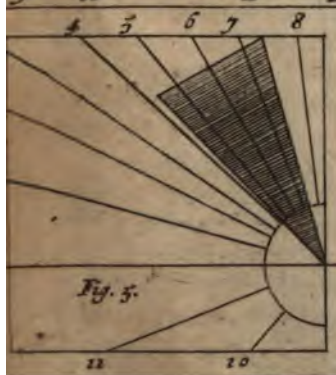
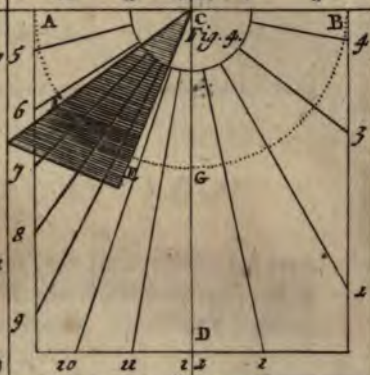
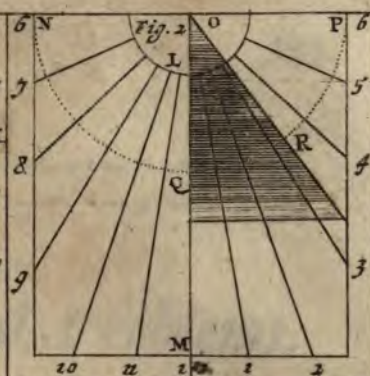
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son) as is discovered in the 4th Problem of this Book for *Upright Declining Plains*.

Thus have you the manner of making all manner of plain Sun-Dials by the Globes, not only by the Natural way, as they are Naturally represented upon the Globe; but by an Artificial way also, by referring them to New Latitudes, in which they shall become Horizontal Dials, or at least Upright Decliners. It resteth now that I should say something concerning the inserting of *Tropicks, Parallels, Italian, Babylonish, and Jewish Hours*, as also *Almicanters, Azimuths*, and such other Spherical Lines and Arches as are oftentimes inserted upon Dial-Plains for the delight and curiosity of the Ingenious: but these, with some other things concerning the *Gnomonicks*, I shall refer to another Treatise by it self.

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## *Astrological Problems.*

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### INTRODUCTION.

**A**STROLOGY consisteth principally of two Parts, viz. The one *Mathematical*, as is the *Astronomical* Part ; the other *Judiciary*, as is the *Astrological* Part.

The *Mathematical* Part teacheth how in a *Scheme* or *Figure* ( as they call it ) to represent the *Face* of the Heavens *in Plano*, for any Hour of the Day or Night, at all times of the Year, and in all Parts of the World.

The *Astrological* Part Teacheth how (from the sight of the said Position of the *Scheme* or *Figure* of the Heavens at the time of its Erection) to give a determinate Judgment of what was demanded upon that Erection of the *Scheme* or *Figure* : as of *Annual Revolutions*, *Elections*, the *Nativity* of a Person.

The

The principal Authors that have given their Opinions concerning the dividing of the Heavens into 12 Mansions or Houses, are, 1. *Ptolemy*, 2. *Alcabitus*, 3. *Campanus*, and 4. *Regiomontanus*: Which last way, is now generally received and practised among the *Astrologers* of these times, and by them termed the *Rational way of Regiomontanus*.

Now, Because (as I said before) that the Erection of a *Figure* of the Heavens is the *Mathematical* or *Astronomical* Part of *Astrology*, I shall therefore shew how by the *Globes* to Erect a *Figure* of the Heavens according to the various Ways of the Four mentioned Authors, and that for the same Latitude and Time.

# P R O B. I.

*How to Erect a Figure of the Heavens in the Latitude of London, 51 deg. 30 min. North, for the 10th day of March, at 49 min. after 9 in the Forenoon; at which time the Sun enters into the first Scruple of Aries this Year 1675.*

I. *According to the (esteemed) Rational way of Regiomontanus.*

*Defini-* **T**He Heavens are divided into Twelve Houses or Mansions, by Twelve Semicircles of Position; for which purpose, to some *Globes*, there is made one of Brass, which is fixed in the Intersections of the *Meridian* and *Horizon*, by the Elevation or Depression whereof the Heavens may be divided into Parts or Houses through each degree of the *Ecliptick*.

*Defini-*

*Definition 2.]* Of these XII Houses or Mansions of Heaven, Four are called *Cardinal*, as (1.) The *Horoscope*, or *Ascendant*, or *Cuspis* of the First House. (2.) The *Medium Cæli*, or Angle of the South, or *Cuspis* of the Tenth House. (3.) The *Descendant*, or Angle of the West, or the *Cuspis* of the Seventh House. (4.) The *Imum Cæli*, or the Angle of the North, or the *Cuspis* of the Fourth House.

*Definition 3.]* *Regiomontanus* divides the Heavens into XII Houses according to his way, by the Circle of *Positions* passing through every 30th degree of the *Equinoctial*, and cutting the *Ecliptick* at several points, which are the *Cuspises* of the several Houses:—— So that when the *Globe* is set to the Latitude, and the Hour-wheel Rectified and brought to the given Hour, you have the *Cuspises* of the Four *Cardinal* Houses given: For,

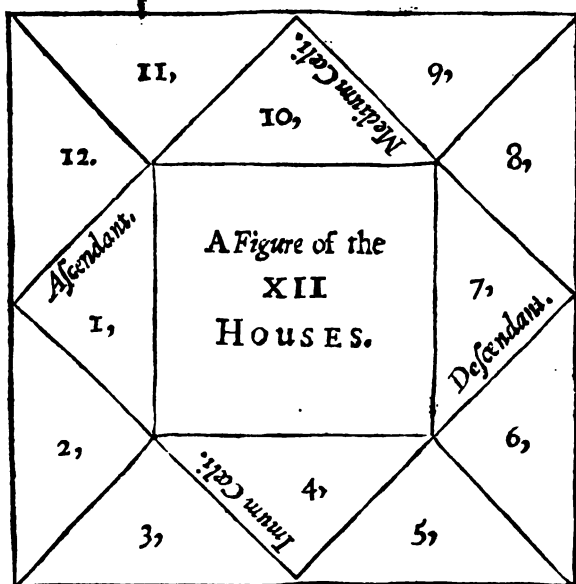
The degree { East-side of the *Horizon*,  
of the E- } South-part of the *Meridian*,  
cliptick cut } West-side of the *Horizon*,  
by the { North-part of the *Meridian*,

Gives the *Cuspis* { First }  
of the { Tenth } House.  
{ Seventh }  
{ Fourth }

The *Cuspises* of the other 8 Houses are found by the motion of the Circle of *Position*, as shall be shewed by and by.

*Definition 4.]* The Houses are denominated by 1, 2, 3, 4, &c. to 12, from the *Ascendant* down-  
M wards

wards to the *Imum Cæli*, up again to the *Descendant*, and again by *Medium Cæli* down to the *Ascendant*. As in the following Scheme.



Let this suffice for *Definition*, and now we will come to the *Practice* by the *Globes*.

*Practice.*]

*Practice.*] First, to the day proposed, the 10th of March, find (by the First *Astronomical Problem*) the Sun's Place in the *Ecliptick* at Noon, which you shall find to be in 0 deg. 5 min. of *Aries*.

Secondly, Set the *Globe* to the Latitude 51 deg. 30 min.

Thirdly, Bring the *Sun's* Place at Noon (0 deg. 5 min. of *Aries*) to the Meridian.

Fourthly, Turn the *Globe* about till the *Hour-Index* point to the *Hour* given, viz. to 49 min. after 9 in the Morning.

Lastly, The *Globe* being in this *Position*, fix it.

The *Globe* being fixed in this *Position*, you shall find that the *East-Semicircle* of the *Horizon* doth cut the *Ecliptick* in 0 deg. 29 min. of *Cancer*, which is the *Sign* then *Ascending*, and must be placed upon the *Cuspis* of the First House.

Then cast your Eye upon the Intersection of the *South-Part* of the *Meridian* and the *Ecliptick*, and there you shall find the *Ecliptick* cut by the *Meridian* in 25 deg. of *Aquarius*, and that point of the *Ecliptick* is then in the *Medium Cæli*, and must be set upon the *Cuspis* of the Tenth House.

Also you shall find that the *West-Semicircle* of the *Horizon* cuts the *Ecliptick* in 00 deg. 29 min. of *Capricorn*; which Point is then *Descending*, and must be placed upon the *Cuspis* of the Seventh House.

Lastly, You shall find that the *North-Part* of the *Meridian* doth cut the *Ecliptick* in the 25th deg. of *Leo*, which point is then upon the *Imum*



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*Cæli*, and must be placed upon the *Cuspis* of the Fourth House.

Thus have you found the Points of the *Ecliptick* which do occupy the *Cuspises* of the Four Cardinal Houses : Now for the other Eight Houses.

Let the *Globe* still rest in its former *Position*, and then,

First, Bring the *Circle of Position* to its place on the *East-side* of the *Horizon* ; and being there fixed, raise it upwards towards the *Meridian*, till 30 deg. of the *Equinoctial* be intercepted between the *Horizon* and the *Circle of Position* ; and then you shall find that the *Circle of Position* will intersect the *Ecliptick* in 20 deg. of *Taurus* ; which degrees must be set upon the *Cuspis* of the Twelfth House.

Secondly, Move the *Circle of Position* yet higher towards the *Meridian*, till 30 deg. more of the *Equinoctial* be intercepted between it and the *Horizon*, (in all 60 deg.) and when it so doth, you shall find the *Circle of Position* will cut the *Ecliptick* in 36 deg. of *Pisces* ; which Point must be set upon the *Cuspis* of the Eleventh House.

The *Meridian* gives the *Cuspis* of the Tenth House in 25 deg. of *Aquarius*, as before.

Thirdly, Move the *Semicircle of Position* from the *East-side* of the *Horizon* to the *West-side*, and move it downwards from the *Meridian*, till 30 deg. of the *Equinoctial* be intercepted between the *Meridian* and *Circle of Position*, and then you shall find that the *Circle of Position* will intersect the

the *Ecliptick* in 7 deg. of *Aquarius*; which point must be set upon the *Cuspis* of the Ninth House.

Fourthly, Move the *Circle of Position* yet lower by 30 deg. i. e. 60 deg. from the *Meridian* downwards, and then you shall find the *Position Circle* to cut the *Ecliptick* in 21 deg. of *Capricorn*; which Point must be set upon the *Cuspis* of the Eighth House.

The *Descendant* or *Cuspis* of the Seventh House is the Intersection of the *West-side* of the *Horizon* and *Ecliptick*, which is in 00 deg. 29 min. of *Capricorn*, as before.

And thus have you found the *Cuspises* of the Four Houses above the *Horizon*, besides the *Ascendant* and the *Medium Cæli*; viz. of the 12, 11, 9 and 8 Houses. Now the *Cuspises* of the Four other Houses under the *Earth* have the same deg. of the opposite Signs upon them: For,

20 deg. of <i>Taurus</i>	}	being upon the	}	house,
26 deg. of <i>Pisces</i>				
7 deg. of <i>Aquarius</i>				
21 deg. of <i>Capricorn</i>				
				<div style="display: flex; justify-content: space-between; width: 100px;"> <span>12</span> <span>11</span> <span>9</span> <span>8</span> </div>

20 deg. of <i>Scorpio</i>	}	will be on the	}	house.
26 deg. of <i>Virgo</i>				
7 deg. of <i>Leo</i>				
21 deg. of <i>Leo</i>				
				<div style="display: flex; justify-content: space-between; width: 100px;"> <span>6</span> <span>5</span> <span>3</span> <span>2</span> </div>

For the Six Signes

*Aries, Taurus, Gemini, Cancer, Leo, Virgo,*  
are opposite to

*Libra, Scorpio, Sagittarius, Capricorn, Aquarius, Pisces.*

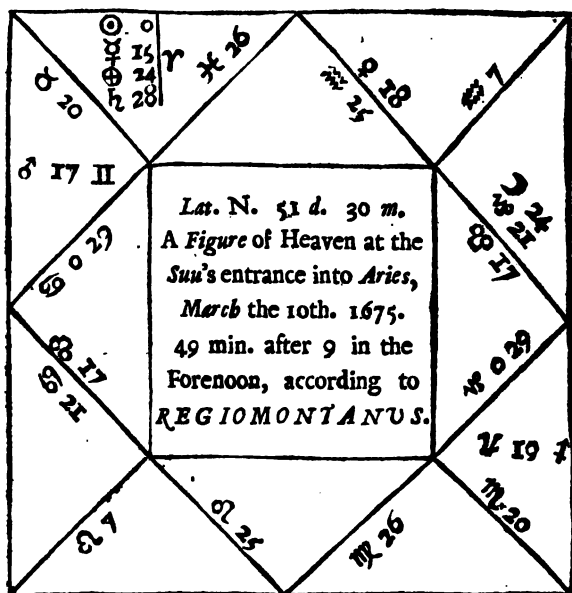
And this is the manner how (by the *Globe*) to erect a *Figure* according to the (reputed) *Rational way* of *Regiomontanus*.

Now if you would insert the Places of the *Planets* into your *Figure*, (for it is them that the *Astrologer* principally giveth *Judgment* by) your best way will be to have recourse to some good *Ephemeris* (if you cannot *Calculate* them from *Astronomical Tables*) and so may you find the Places of the several *Planets* at the time for which this *Figure* was Erected (*viz.* March 10. 1675. 49 min. after 9 in the Forenoon) to be as followeth, *viz.*

♄ Saturn	} is in {	28 Aries.
♃ Jupiter		19 Sagittarius.
♂ Mars		17 Gemini.
☉ Sol		00 Aries.
♀ Venus		18 Aquarius.
☿ Mercury		15 Aries.
☾ Luna		24 Capricorn.
♁ Dragons Tail		17 Capricorn.
♁ Dragons Head	}	17 Cancer.

Having thus obtained the Places of the *Planets*, either by *Calculation*, by *Ephemerides*, or *Instrument*, you may Place them in their Correspondent places in your *Figure*, as is here done, and so is your *Figure* ready to give your *Judgment* upon.

Lat.



M 4

II. 70

II. To Erect a Figure of the Heavens for the fore-mentioned time, Anno 1675. March the 10th, at 49 min. past 9 in the morning.

According to Campanus.

*Defini.* THE *Cuspises* of the Four Cardinal Houses according to Campanus, viz. the *Ascendant*, *Mid-heaven*, *Descendant*, and *Iyrum Cæli*, are the same as they were according to *Regiomontanus*. But, as *Regiomontanus* divided the Houses by the *Circle of Positions* passing through each 30th degree of the *Equinoctial*, and intersecting the *Ecliptick* in the *Cuspises* of the several Houses; *Campanus* divides the XII Houses of Heaven by the *Position-Circles* passing through each 30th degree of the *Prime Vertical Circle*, (or *Azimuth of East or West*) and so intersecting the *Ecliptick* in the *Cuspises* of the several Houses. So that to Erect a Figure according to *Campanus's* way, you must do as followeth, viz.

*Practice.*] You must first set the *Globe* to the Latitude, bring the *Sun's Place* at Noon for the Day given to the *Meridian*, and the *Hour-Index* to 12, and the *Circle of Position* to the *East-side* of the *Horizon*; then turn the *Globe* about till the *Index* point at the given Hour, and then fix the *Globe*. Thus far as in the former way of *Regiomontanus*; and the *Cuspises* of the First, Fourth, Seventh, and Tenth Houses will be the same as in his way. But now to proceed according to *Campanus*.

The *Globe* seated and fixed in this *Position*, bring the *Quadrant of Altitude* to the *Zenith*, and there  
fix



fix it; and bring the lower part of the *Quadrant of Altitude* to the *East*-point of the *Horizon*, and there keeping of it fixed:

1. Elevate the *Circle of Position*, till it cut 30 deg. of the *Quadrant of Altitude*, and then see what degrees of the *Ecliptick* are cut by the *Position-Circle*, which you shall find to be 22 deg. of *Aries*; which point must be set upon the *Cuspis* of the Twelfth House.

2. Move the *Circle of Position* yet 30 deg. higher upon the *Quadrant of Altitude*, namely, to 60 deg. from the *Horizon*, and then see what degree of the *Ecliptick* is cut thereby, and you shall find that the *Position-Circle* cuts the *Ecliptick* in 12 deg. of *Pisces*, which must be set upon the *Cuspis* of the Eleventh House.

The *Meridian* cuts the *Ecliptick* in 25 deg. of *Aquarius*, which is the *Cuspis* of the Tenth House, or *Mid-heaven*, as before.

3. Remove the *Circle of Position*, and also the *Quadrant of Altitude*, from the *East* to the *West*-side of the *Horizon*, and there move him from the *Meridian* downwards, till 30 deg. of the *Quadrant of Altitude* be intercepted between the *Zenith* and the *Circle of Position*, and then see where the *Position-Circle* cuts the *Ecliptick*, which will be in 12 deg. of *Aquarius*; and those degrees must be set upon the *Cuspis* of the Ninth House.

4. Let down the *Circle of Position* 30 deg. more upon the *Quadrant of Altitude*, that is, 60 deg. distant from the *Zenith*, and then look what degrees of the *Ecliptick* are cut by the *Position-Circle*, which you will find to be 28 deg. of *Capricorn*; which degrees must be set upon the *Cuspis* of the Eighth House. The

The *Cuspis* of the Seventh House is 00 deg. 29 min. of *Capricorn*, being the Intersection of the *West-side* of the *Horizon* with the *Ecliptick*, as before.

And by this Artifice you have obtained the degrees belonging to the 1, 12, 11, 10, 9, and 8 Houses above the *Horizon*, according to the way prescribed by *Campanus*: Now the other Six Houses under the *Horizon*, viz. the 2, 3, 4, 5, 6, and 7, are easily found, they being the opposite Points of the *Ecliptick* to the Six above the *Horizon*. So,

				d.	m.
The <i>Cuspis</i> of the	$\left. \begin{array}{c} 1 \\ 12 \\ 11 \\ 10 \\ 9 \\ 8 \end{array} \right\}$ house	being	<i>Cancer</i>	0	29
			<i>Aries</i>	22	0
			<i>Pisces</i>	12	0
			<i>Aquarius</i>	25	0
			<i>Aquarius</i>	12	0
			<i>Capricorn</i>	28	0
The <i>Cuspis</i> of the	$\left. \begin{array}{c} 7 \\ 6 \\ 5 \\ 4 \\ 3 \\ 2 \end{array} \right\}$ house	will be	<i>Capricorn</i>	0	29
			<i>Libra</i>	22	0
			<i>Virgo</i>	12	0
			<i>Leo</i>	25	0
			<i>Leo</i>	12	0
			<i>Cancer</i>	28	0

And thus have you the *Cuspis*es of the several Houses according to the way prescribed by *Campanus*; which *Figure* having the *Planets* placed therein, will stand as in the following *Scheme*.

*Lat.*



III. To Erect a Figure of Heaven for the forementioned time, viz. March 10. 1675. at 49 min. after 9 in the Forenoon.

According to Alcabitius.

*Defini-  
tion.*] **A**lcabitius would have the XII Houses of Heaven to be divided by *Domifying Circles*, or *Circles of Position* drawn from the Poles of the World through every 30th deg. of the Equator, beginning at the point of the *Ecliptick Ascending*; and so counting 30 deg. upon the *Equinoctial* from thence, shall be the *Cuspides* of the several Houses.— Wherefore, to Erect a Figure according to this mode, do as followeth.

*Practice.*]

*Practice.*] You must *Rectifie* the *Globe* to the *Latitude*, bring the *Sun's Place* at *Noon* to the *Meridian*, the *Index* of the *Hour-wheel* to 12 at *Noon*, and turn the *Globe* about to the *Hour* given, and then fix it; so shall the *Ascendant* be the same as in the two former ways, viz. 00 deg. 29 min. of *Cancer*.

Then look what *Meridian* passeth through the *Ascendant*, and count 30 deg. more upon the *Equinoctial*; and that *Meridian* where it passeth through the *Ecliptick* shall be the *Cuspis* of the *Twelfth House*; and 30 deg. forwarder that *Meridian* shall cut the *Ecliptick* in the *Cuspis* of the *Eleventh House*, and so onward till you come to the *Cuspis* of the *Descendant*. And thus,

If from that *Meridian* which passeth through 00 deg. 29 min. of the *Ecliptick*, you count 30 deg. more upon the *Equinoctial*, you shall find that

		d.	m.	
The	First	Meridian of 30	0	29 <i>Cancer</i> ,
	Second	degr. distant	2	29 <i>Gemini</i> ,
	Third	from the <i>As-</i>	2	29 <i>Taurus</i> ,
	Fourth	cendant, will	0	29 <i>Aries</i> ,
	Fifth	cut the <i>Eclip-</i>	28	29 <i>Aquarius</i> ,
	Sixth	tick in	28	29 <i>Capricorn</i> ,

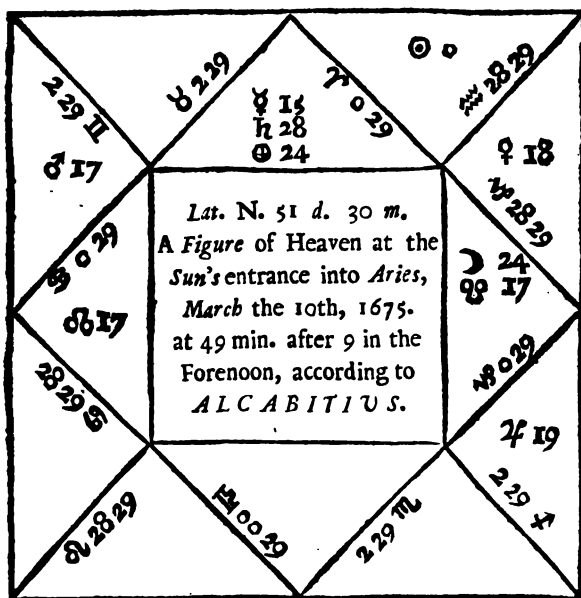
Which are the  
Cusps of the

1
12
11
10
9
8

houses.

And

And the opposite *Signs* and *Degrees* of the *Ecliptick* shall give the *Cuspises* of the Six other under the Earth; namely, of the 7, 6, 5, 4, 3, and 2. And thus your Figure being erected, and the *Planets* placed therein, you will find it to be as in the following *Scheme*.





IV. To Erect a Figure for the forementioned time, viz. March 10. 1675. at 49 min. after 9 in the Forenoon, the Sun then entering Aries in the Meridian of London.

According to the way prescribed by Ptolemy.

*Defini-* **P**TOLEMY adviseth that the *Heavens* should be divided into XII Houses or Mansions, by *Domifying Circles* drawn through the Poles of the *Ecliptick*, and through every 30th deg. thereof from the *Ascendant* downwards, round about. — Wherefore to Erect a Figure of the Heavens according to this way of Ptolemy, do thus.

*Practice.*] Rectifie the *Globe* and *Hour-Circle* as before, and you shall have the same *Ascendant*, viz. 00 deg. 29 min. of *Cancer* to *Ascend*, which is the *Cuspis* of the First House; then 30 deg. forwarder, downwards, will be 00 deg. 29 min. of *Leo*, for the *Cuspis* of the Second House, &c.

		d. m.
So the <i>Cuspis</i> of the	1	0 29 <i>Cancer</i> ,
	2	0 29 <i>Leo</i> ,
	3	0 29 <i>Virgo</i> ,
	4	0 29 <i>Libra</i> ,
	5	0 29 <i>Scorpio</i> ,
	6	0 29 <i>Sagittary</i> ,
And the <i>Cuspis</i> of the	7	0 29 <i>Capricorn</i> ,
	8	0 29 <i>Aquarius</i> ,
	9	0 29 <i>Pisces</i> ,
	10	0 29 <i>Aries</i> ,
	11	0 29 <i>Taurus</i> ,
	12	0 29 <i>Gemini</i> .

will be

And

And so a *Figure* erected for the forementioned time, according to this prescription of *Ptolemy*, and the *Planets* placed therein, will appear as in the following *Scheme* or *Figure*.



And thus have I shewed you the manner of Erecting of a *Figure* of the Heavens, according to the Prescriptions of the Four forementioned Authors, and have placed the *Planets*, *Dragon's Head* and *Tail*, and the Place of *Fortune* in each of them ; by which you may see, that according to these Four Varieties of Erections, the *Planets* keep not in the same Houses, as by the following *Synopsis* appears. For,

Saturn

		accor. to <i>Regiomon.</i>	accor. to <i>Campan.</i>	accor. to <i>Alcabit.</i>	accor. to <i>Ptolomy.</i>
<i>Saturn</i>	} is in {	XI	XII	X	X
<i>Jupiter</i>		VI	VI	VI	VI
<i>Mars</i>		XII	XII	XII	XII
<i>Sol</i>		XI	XI	IX	IX
<i>Venus</i>		IX	IX	VIII	VIII
<i>Mercury</i>		XI	XI	X	X
<i>Luna</i>		VIII	VII	VII	VII
<i>Dragons-tail</i>		VII	VII	VII	VII
<i>Dragons-head</i>		I	I	I	I
<i>Part of Fort.</i>		XI	XII	X	X

## P R O B. II.

*Having the Longitude and Latitude, or the Right Ascension and Declination of a Star, Planet, or Comet, how to find the Place thereof upon the Globe, and to insert it therein if need require.*

**W**Hat the Longitude, Latitude, Right Ascension and Declination of a Star or Planet is, you have heretofore defined; and in the last Problem you are taught how to Erect a Figure of the Heavens, Four several ways. Now if you would see (upon the Globe it self) in what House any of the Planets are, without Erecting a Figure, you were best to make Marks, or set Characters of those Planets, Comets, or the like, upon the Globe, before you delineate your Figure upon Paper; which to effect, do thus.

I. By

I. By the Longitude and Latitude given:

If the Latitude of the *Star*, *Planet*, or *Comet* be  $\left\{ \begin{array}{l} \text{Northward} \\ \text{Southward} \end{array} \right\}$  Elevate  $\left\{ \begin{array}{l} \text{North-Pole} \\ \text{the} \\ \text{South-Pole} \end{array} \right\}$  of the *Globe* to 66d. 30m. then will the Pole of the *Ecliptick* be in the *Zenith*, and the *Ecliptick-circle* will lie in the very Plain of the *Horizon*; in which Position of the *Globe*, screw the *Quadrant of Altitude* in the *Zenith*, over the Pole of the *Ecliptick*. — This done, bring the Point of *Longitude* of the *Planet* in the *Ecliptick* to the *Quadrant of Altitude*, and count the *Latitude* of the *Planet* upon the *Quadrant*, and under the degree of *Latitude* shall be the point upon the *Globe* in which the *Planet* or *Star* in the Heavens is.

And so the *Longitude* of the *Seven Planets* being as it is expressed in the following *Table*, such *Longitude* and *Latitude* they had at the time of the *Erection* of the former *Figure*, *March 10. 1675.* at 49 min. after 9 in the Forenoon. Now, if you find their respective Points upon the *Globe* (as I have now shewed you how to do) you may then, not only see in what House each of them shall be; but also what *Fixed Stars* are there, and what *Fixed Stars* are in the other Houses also.

The Longitude of	♄ Saturn	27	49	♈	And the Latitude	2	17	M. A.
	♃ Jupiter	18	55	♈		0	38	S. D.
	♂ Mars	17	24	♈		1	48	S. A.
	☉ Sol	00	00	♈		0	00	
	♀ Venus	17	56	♈		3	44	S. D.
	☿ Mercur.	15	15	♈		1	07	S. A.
	☾ Luna	24	47	♈		0	35	S. D.
				N				II. By



II. *By the Right Ascension and Declination given.*

Suppose a *Star*, *Planet*, or *Comet* to have 147 deg. 43 min. of *Right Ascension*, and 33 deg. 33 min. of *North Declination*, as the *Star Regulus*, or the *Lion's Heart* hath, and you would find its place upon the *Globe* :

Count 147 deg. 43 min. the *Stars Right Ascension* upon the *Equinoctial* from the beginning of *Aries*, and bring that point of the *Equinoctial* to the *General Meridian*; and keeping the *Globe* there, count 33 deg. 33 min. the *Stars Declination*, upon the *Meridian* upwards, (because the *Stars Declination* is *Northward*) and that point shall be the place of *Regulus* upon the *Globe*. And thus may any part, or point, in the *Heavens* be found upon the *Globe*, if either the *Longitude* and *Latitude*, or the *Right Ascension* and *Declination* of that point be first known.

## P R O B. III.

*To know in what House, or under what Circle of Position, any Star, Planet, or Point of the Ecliptick is.*

**R**ectifie the *Globe* to the *Latitude*, the *Quadrant of Altitude* to the *Zenith*, the place of the *Sun* in the *Ecliptick* to the *Meridian*, and the *Hour-Circle* to 12; then turn the *Globe* about to the *Hour* given, and bring the *Quadrant of Altitude* to the *East* or *West* Points of the *Horizon*, and there fix the *Globe*: Then move the *Circle of Position* upwards, till it touch the *Star*, *Planet*, or other Points of the *Ecliptick*, which you desire to know



know the *Circle of Position* of, then shall the *Position-Circle* cross the *Quadrant of Altitude* in the number of that *Circle of Position* in which that *Star, Planet, or other Point of the Ecliptick* is.

Thus, If at the time of the *Erection* of the former *Figure* it were required to know, in what *Circle of Position* (or *House*) the *Pleiades* or *Seven Stars* were; Rectifie the *Globe* as before, and bring the *Position-Circle* to the *Pleiades*, then shall the *Circle of Position* cut the *Quadrant of Altitude* in 42 deg. and under that *Circle of Position* are the *Pleiades* or *Seven Stars* at that time, and so consequently in the XIIth *House*.

I might here shew how to find the place of the *Thing* which *Astrologers* call the *Part of Fortune*. Also how (as they call it) to *Direct a Figure*, and to find out *Revolutions, &c.* But forasmuch as these things are not so *Mathematical* as to require a *Globe*, or other *Mathematical Instruments*, either to *Demonstrate* them by, or to ease the *Operation*; I shall refer them that have occasion for such things, to the *Arithmetical working* of them by the *Pen*, as most convenient, and reserve the *Globes* for other *Purposes*.

## P R O B. IV.

*Of the Planetary Hours, how to find the Length thereof, and what Planet it is that Reigneth any common Hour of the Day or Night.*

*Defini-* **A** *Planetary Hour for the Day, is the*  
*tion 1.]* 12th part of the Artificial Day  
 counted from the time of the *Sun's Rising* to its  
*Setting*; and a *Planetary Hour for the Night, is*  
 the 12th part of the Artificial Night counted from  
 the time of the *Sun Setting* to the time of its next  
*Rising*: So that the *Planetary Hours* are not of the  
 same length all the year long, as the common  
 Hours of 60 min. are, but are some times of the  
 year longer, and sometimes shorter. — For,  
 when the Artificial Day is above 12 Hours long,  
 (as it is all the time that the *Sun* is in the Six  
 Northern Signs) then doth a *Planetary Hour* con-  
 tain more than 60 min. — And when the Ar-  
 tificial Day is less than 12 Hours long, (as it is  
 all the time that the *Sun* is in the Six Southern  
 Signs) then doth the *Planetary Hour* contain less  
 than 60 min. — But when the *Sun* is in the  
*Equinoctial*, and the Artificial Day and Night are  
 equal (each containing just 12 hours) then the  
 common Hour and the *Planetary Hour* are the  
 same, either of them containing just 60 min.

*Definit. 2.]* The *Planetary Hours* take their De-  
 nominations from the *Planetary Names* of the Days  
 of the Week, as

Sunday

Sunday	} hath for its Planetary Name	Sol.
Monday		Luna.
Tuesday		Mars.
Wednesday		Mercury.
Thursday		Jupiter.
Friday		Venus.
Saturday		Saturn.

So that upon whatsoever Day of the Week you would know what *Planetary* Hour it is, the first *Planetary* Hour of that Day or Night is called by the *Planetary* Name of that Day of the Week; as, if it be *Monday*, then *Luna* governs the first *Planetary* Hour that Day and Night; if *Sunday*, *Sol*; if *Wednesday*, *Mercury*, &c.

I. To find the Length of a *Planetary* Hour at any time.

*Practice.*] For the Day proposed, (after you have Rectified the *Globe* to the *Latitude*, &c.) bring the *Sun's* Place in the *Ecliptick* for that Day to the East-side of the *Horizon*, and see what degree of the *Equinoctial* is cut by the *Horizon*; then bring the *Sun's* Place to the Meridian, and then again see what degree of the *Equinoctial* is then cut by the *Horizon*: the Difference of those degrees being divided by Six, because there are six *Planetary* Hours between *Sun-Rising* and our 12 at Noon, (which is always the Sixth *Planetary* Hour) and that Quotient shall be the number of minutes contained in a *Planetary* Hour all that Day. Thus for Example, On *Tuesday* the 27th of *July* 1675. the *Sun's* Place will be found to be in 14 deg. of *Leo*; bring 14 deg. of *Leo* to the East-part of the *Horizon*, and you shall find that 115 deg. of the *Equinoctial* are (at that time) cut by the *Horizon*; which deg. note down, or mark upon the *Globe*.---



Then bring 14 deg. of *Leo* to the *Meridian*, and then you shall find 226 deg. of the *Equinoctial* cut by the *Horizon*; so that if you take with your *Compasses*, or count the number of deg. of the *Equinoctial* contained between 115 deg. and 226 deg. you shall find them to be 111 deg. [or if you Substract 115 from 226, which is easiest, the Difference will be 111 also] and so many degrees of the *Equinoctial* do pass the *Meridian* in Six *Planetary* Hours: Wherefore divide 111 by 6, and in the Quotient you shall find 18 deg. 30 min. to pass the *Equinoctial* in One *Planetary* Hour; and so counting 15 deg. for 1 Hour, and 1 deg. for 4 min. of time, you shall find the Length of the *Planetary* Hour to contain One common Hour and 14 min. more, which is one Hour and a Quarter wanting one Minute.----- And the length of a *Planetary* Hour for the Night will contain only 46 min. which is less than One common Hour by a Quarter wanting one Minute.

II. To find what *Planetary Hour* of the Day or Night it is.

On the forementioned day, *Tuesday* the 27th of *July* 1675. Let it be required to know what *Planet* ruleth that day at 5 of the clock in the afternoon. The Length of the *Planetary* Hour for that Day is 1 Hour 14 min. Wherefore, the *Globe* being Rectified, bring the *Index* of the Hour-Circle to 5 a Clock, and then count the number of deg. which were cut by the *Horizon* in the last Operation, and the degrees of the *Equinoctial* now at the *Horizon*, and you shall find them to be 187 deg. which reduced into minutes of time, (by multiplying them by 4) gives 748, which 748 min. being divided by

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by 74, the number of minutes contained in one *Planetary* Hour, the Quotient will be 10 hours and 8 min. shewing that there are Ten *Planetary* Hours past, since the *Sun*-Rising, and that there are 8 min. of the 11th hour past also.

**III. To find what Planet governeth that Hour of the Day.**

For the effecting hereof, the *Globe* standeth you in no stead at all; wherefore observe the *Table* following and its Use.

The T A B L E.

Governours of the day.	Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	Governours of the night.
Sol.	1	12	9	0	10	0	11	Jupiter.
Venus.	2	0	10	0	11	1	12	Mars.
Mercury.	3	0	11	1	12	2	0	Sol.
Luna.	4	1	12	2	0	3	0	Venus.
Saturn.	5	2	0	3	0	4	1	Mercury.
Jupiter.	6	3	0	4	1	5	2	Luna.
Mars.	7	4	1	5	2	6	3	Saturn.
Sol.	8	5	2	6	3	7	4	Jupiter.
Venus.	9	6	3	7	4	8	5	Mars.
Mercury.	10	7	4	8	5	9	6	Sol.
Luna.	11	8	5	9	6	10	7	Venus.
Saturn.	12	9	6	10	7	11	8	Mercury.
Jupiter.	0	10	7	11	8	12	9	Luna.
Mars.	0	11	8	12	9	0	10	Saturn.



*The Use of the aforesaid Table.*

Having by former Rule found what *Planetary* Hour it is, if you would know what *Planet* it is that Reigneth that Hour, in the Head of this *Table* seek the Day of the Week (in this Example, *Tuesday*) and the *Planetary* Hour of the Day (in this Example 12 hours in the Forenoon : ) in the same Column, and right against it in the first Column on the Left Hand, you shall find *Venus*, which shews that at 5 of the Clock in the Afternoon that day *Venus* governeth, and hath governed 8 min. of her Hour.

Also in the same *Table* you shall find against 10 under *Tuesday* in the last Column towards the Right Hand, the word *Mars*, shewing that *Mars* governeth the 10th *Planetary* Hour for the Night; and hath governed 8 min. of his Hour.

# GEOGRAPHY AND NAVIGATION

Made easie :

O R,

A Plain Description and Use

O F T H E

*Terrestrial GLOBE.*

---

**B**Eing to contemplate the entire Sphere of the World, we begin first with the Earth.

*Of the Figure of the Earth.*

**D**ivers and various have been the Opinions concerning the Figure of the Earth among the ancient Philosophers, some of them contending for a Plain, others an Hollow, others a Cubical, and some a Pyramidal Form ; yet this  
A n Opinion

Opinion of its Rotundity with greatest Consent of Reason at length prevailed, and is now generally received and embraced; the rest being all exploded and contemned. The natural place of the Water is to be above the Earth; and so it was in the first Creation of it, compassing the Earth round about, *Gen. 1. 9.* But for the Use of Man, and other living Creatures, God made a Separation of them, causing the Waters to sink down into large hollow Channels and Caverns prepared to receive it, that so the dry Land might appear above it. Notwithstanding which Separation they do both remain together, not covering one another as at the first, but intermingled one with another, and that so exactly, as they now make but one round Body, having the same Center, Surface, or Convex Superficies; yet not so round, but that we admit of its Inequalities, by reason of those so great Eminences of Hills and Depressions of Vallies.

*Of the Substance or Constitution of the Earth.*

**T**HERE are divers Opinions of Philosophers concerning this matter. The *Peripateticks* number 4 Elements of the Earth and whole Sublunary World, *viz.* Fire, Air, Earth, and Water. Our Chymists make 3 Principles, Salt, Sulphur, and Mercury. The *Sieur de Clos*, in his *Principes de Mixtes Naturels*, tells us, That the material constitutive Parts of our habitable Globe, are Earth, Water, and Air: The dense Earth makes the Solidity of the Mass of this Globe; the liquid Water soaking binds together the discontinued earthly Particles; the thin and subtile Air girts and encompasses the Earth and Water, filling up the Spaces. *Varenius* saith, That all Bodies, and the  
Parts

Parts of the Earth, are resolv'd into 5 Elementary Substances, *viz.* Water, Oyl or Sulphur, Salt, Earth, and a certain Spirit which the Chymists call *Mercury*.

We cannot indeed well tell what kind of Substance the Earth is toward the Center: all that we know of it below the Surface, is only so far as Men have digged. In those Parts we find these Metals, Gold, Silver, Copper, Tin, Lead, Iron, Stone, Coal, Clay, Salt, &c. besides an Infinity of different kinds of Earth. As to what is lower or towards the Center, we may have some uncertain Conjectures, but our Knowledge goes no further than our Sense and Observation do in this matter.

'Tis probable that the Land is one continuous Substance, and that no part of it is disjoin'd, or entirely separated from the rest; of an irregular Shape and Figure, having many Heights and Hollows along all its Surface; in which Cavities or Hollows the Sea or Ocean resteth, and is contained therein: And as the higher parts of the Land, or that which is above the Waters, is not equally high, but there are Mountains and Valleys in it; So those Cavities are not equally of a Depth, some of them more, others less; therefore the Sea is deeper in some places than it is in others: So likewise the Land is not equally high, but there are Mountains and Valleys in it. The Shoar is somewhat higher than the Sea, otherwise the Water of the Sea would flow in upon that of the Rivers. Some Countries indeed, as *Holland* and *Zealand*, lie lower than the Sea, but then their Shoars are higher than it, or they have high Ramperts of Earth or Stone to defend or keep it off: But for the most part, Countries are higher than the Shoar, according

ding to their distance from it, which is plain from the Current of Rivers, which rise generally in Inland Places, and run toward the Sea. Besides that vast Cavity or Channel for the Sea, there are innumerable Gulphs and Recesses, Whirlpools, Abysses, and secret Passages within the Earth : for Rivers have been found in the bottom of deep Mines, Whirlpools in several parts of the Sea, which in all appearance proceed from some Passage that the Water has downwards by a subterraneous Canal ; several Rivers dive under Ground, and hide themselves ; and Salt-water Springs are found in many places, which doubtless flow from the Sea ; of which more hereafter.

Dr.*Hook* in his Lectures of Comets tells us that, what the Density of the innermost Parts of the Earth we live on is, none knows ; for though we find the Parts on which we tread to be very compact, and though by the Industry of Miners it hath been proved so also to the depth of many hundred Foot ; and though it hath been found so even to a greater Depth by the Soundings of the bottom of the Sea, yet none can bring an undeniable Proof, that the same is so solid to 25 Miles deep ; much less that it is so to the Center. If therefore the external Shell of this Globe were broken and removed, 'tis not impossible but that the middle Parts thereof may be of the same nature with the middle Parts of the Comet's Body, *vis.* Of a loose and pervious Texture, and almost in a state of Fluidity ; and that those Parts (were the superficial parts of the Shell removed) might, like these of Comets, expand themselves into the encompassing *Æther*.

There



There is one Argument to prove to us that there may be such a Looseness of the internal Parts of the Earth, and that is, that the Magnetical Virtue varies; which Virtue, without Controversie, is diffused thro' the whole Body of the Earth, and which hath a relation to the whole Globe, and to every magnetical part thereof.

Now this magnetical Virtue (which may be called one Emanation of the *Anima Mundi*, as Gravity may be called another) being diffused through every part of it, and giving to every magnetical Body, and every piece of it, tho' infinitely divided, the same Proprieties it hath it self: This magnetical Virtue, saith he, having such a Relation, and being forced thus to vary, 'tis probable that the internal Parts, to which it hath a respect, have a Variation likewise; and consequently, that these internal Parts which are supposed generally very dense, compact, and very closely and solidly united, may be notwithstanding more loose and ununited, and movable from certain Causes.

*Of the Magnitude of the Earth.*

THE Terraqueous Globe is but an imaginary Point compared to the vast Expansion of the Universe, tho' of it self of great Magnitude. But before I proceed to the Solution of this Question, it is necessary to give a short Account of the Measures formerly used by the Ancients, and what our modern Measures are, so far as we know them, with their Proportions to our own.

The ancient Measures are generally estimated thus: The Stadium of the *Greeks* contained 600 of their Feet, equal to 625 Roman Feet, as 'tis generally taken; for the *Grecian* Foot was a little

A a 3

larger

larger than that of the Roman. The old Roman Mile contained 1000 Paces, or 8 of their Stadia. The *Alexandrian* Stadium was bigger than the *Grecian*, as 144 to 125. The *Orgyia* of the *Greeks* contained 6 Foot. The Cubit was  $1\frac{1}{2}$  Foot. *Xylander* in his Translation of *Strabo*, always renders it an Ell. A Furlong is defined by *Herodotus*, a very ancient *Greek* Author, to consist of 600 Feet; and also affirmed by *Suidas*: Yet *Hero Mechanicus* would have a Furlong to contain 100 Fathoms, a Fathom 4 Cubits, a Cubit 1 Foot  $\frac{1}{2}$ , or 24 Digits. *Censorinus* proposeth 3 several kinds of Furlongs: the first of which is the *Italian*, consisting as aforesaid of 625 Feet: The second is the *Olympian*, containing 600 Feet: The Third is the *Pythian*, consisting of 1000. And *Pliny* in his 2<sup>d</sup> Book, chap. 23. tells us, That the *Italian* Furlong, containing 625 Roman Feet, is equal to the *Olympian*, consisting of 600 *Grecian* Feet as aforesaid; for the *Grecian* Foot exceeds the Roman by a Twenty fourth part, as much as is the difference betwixt 600 and 625. The *Arabian* Mile was equal to  $7\frac{1}{2}$  *Alexandrian* Stadia. The old *Arabian* League was reckon'd to be the 25<sup>th</sup> part of a Degree, so that 25 of them made  $73\frac{7}{10}$  *English* Miles. The *Schanus* of the *Egyptian* Measure contained 60 Stadia, teste *Herodotus*. The *Parasang*, which was the old *Persian* Mile, contained 30 Stadia, or 3000 of their Paces.

*Willebrodus Snellius* in his Book Entituled, *Eratosthenes Batavius*, has with much Diligence compared some ancient Measures, as also the Measures of sundry Foreign Countries with the *Rhynland*-Foot; and, amongst the rest, our *English* Foot, according to the Size thereof sent him from the Standard at *Guild-Hall*; which, by Mr. *Norwood* are



are here compared to our *English Foot*, as he hath there done to the *Rhynland*. Supposing therefore our *English Foot* to be divided into 1000 equal parts, this Table shews you how many of those parts are contained in other Ancient and Foreign Feet, viz. Of such parts as the *English Foot* 1000, the ancient *Roman Foot* contains 1033. The ancient *Greek Foot* contains 1076. The *Babylonian Foot* 1211. The *Alexandrian Foot* 1240. The *Antiochean Foot* 1405. The *Arabian Foot* 1102. The *Rhynland Foot* 1033. the same with the *Roman Foot*. The *Dort Foot* 1085. The *Middleburgh* 992. The *Amsterdam* 934. The *Antwerpt* 939. The *Lorraine* 939. The *Hafnian Foot* in *Denmark*, 965. The *Paris Foot*, called the *King's Foot*, 1090. The *Venice Foot*, 1157. The *Toledo Foot*, 896. The *Nurenburg* 1006. The *Strasburg Foot*, 920.

Because it would be impossible to measure the entire Compass of the Earth, the Ancients reduced it to the Measure of one part, from whence the bigness of the whole may be concluded, viz. To the Quantity of one Degree, or of one 360th part of its Circumference. Now according to several Experiments made, the Quantity of a Degree is variously found to be. By *Ptolemy* to contain  $66\frac{2}{3}$  Miles. By *Almamon* or *Mainon* an *Arabian King* or *Caliph* of *Babylon*,  $56\frac{1}{4}$ . So that between *Ptolemy's* Observation and theirs, there is the difference of 10 Miles in every Degree. But if these *Arabians* reckon'd the 500 *Stadia*, which *Ptolemy* had established as the Measure of one Degree, to be equal to  $66\frac{2}{3}$  of their Miles, then one of their Miles was equal to  $7\frac{1}{2}$  *Stadia*, (which if the *Alexandrian Stadia*) one Degree according to his Computation contained  $61\frac{1}{2}$  of the old *Italic*

Miles, which had eight *Grecian* Stadia in each of them, which makes 47188 Toyses of *Paris*. *Straba* and *Hipparchus* reckon'd the Measure of a Degree 700 Furlongs or Stadia. *Eratosthenes* 644 $\frac{4}{5}$ . *Possidonius* and the ancient *Arabians* 666 $\frac{2}{3}$ . *Ptolemy* and our *English* 500. The latter *Arabians* 566 $\frac{2}{3}$ . The *Dutch* and *Germans* 480. So that a Degree of the Heavens contains upon the Surface of the Earth, according to common Computation, of *Italian* and *English* Miles 60; Ordinary *French* Leagues 20; *Spanish* Miles 17 $\frac{1}{2}$ ; *German*, *Dutch*, *Danish*, and *Polish* Miles, 15; *Hungary* 10; *Swedish* 12; Versts of *Muscovy*, 80; *Persian*, *Arabian*, and *Egyptian* Parasanga, 20; The *India* Cos, 24; The *Stades* of *China*, 250, The *Inks* of *Japan*, 400.

So great is the difference of Opinions amongst all Authors concerning the Compass of the Earth, and yet every one of these Opinions grounded on the Authority of great Men; so that in this great Diversity it is doubtful whom we should follow. And yet if we should desire to know the Cause of all these Dissentions, even that also is altogether uncertain. It may suffice in brief to say, that we are indeed ignorant of the ancient Measures, all the Measures that the Ancients have left us being altered in time. However, I shall exhibit to your View, all those late Experiments which carry in them any shew of Probability.

*Of the Measure of one Degree of a great Circle of the Earth, according to our Modern Geographers.*

There is not any thing that has embarras'd the Knowledge of History and Geography more than this, That one Age or Nation has not a certain Knowledge of the just Quantity of the Measures which have been used in a former Age, or in a different Nation, with reference to their own. We meet with the Names of the ancient Measures, which were in use amongst the *Greeks* and *Romans*, in their Writings; but we know not their exact Dimension, or what Proportion they had to these now in use among us. Nor can this ever be remedied but by agreeing upon some fixed and unalterable thing in Nature, which may serve as an universal Standard, to which the Measure of all Times and Places may be reduced, and bear a certain Proportion.

Therefore it was that the Gentlemen of the Academy for the Sciences at *Paris*, when they had resolved to try what the Measure of one Degree of a great Circle of the Earth, (or the 360th part of the Earth's Circuit was) that other Nations and After-Ages might know the Quantity of it in their own Measures; they compared the Toyse of the Grand Chastelet of *Paris*, which was the Measure they made use of, with an Original taken from Nature it self, viz. The Length of a Pendulum for Seconds. The way they did it was this: They had two great Pendulum Clocks, each of whose single Vibrations was one Second of Time conformable to the mean Motion of the Sun,



Sun: by these they determined the Length of a single Pendulum, and found it to be 36 Inches  $8\frac{2}{3}$  Lines (the Line is  $\frac{1}{12}$  of an Inch) of the aforesaid Measure of the Chastelet of *Paris*. They took the Double of this for an Universal Measure, which has the same Proportion to the *Parisian* Toyse, which 881 has to 864. Thus if the Length of the Pendulum for Seconds be once adjusted to the usual Measures of every Country, we may know the Proportions of their different Measures as exact, as if the Originals had been compared; and might be established as an universal Standard of Measures throughout the World; only we must suppose that the difference of Places causeth no sensible Variations in the Length of the Pendulums, which will require more Experiments.

The Length of a Pendulum for Seconds, according to these Measures, is,

	<i>Inches</i>	<i>1000 parts of an Inch.</i>
Of <i>London</i> Measure	39	126
<i>Paris</i>	36	708
<i>Rhinland</i>	37	974
<i>Boulogne</i>	31	352
<i>Florence</i>	20	480
<i>Roman</i>	40	452

Hence,

Supposing the <i>Lond.</i> Foot to be	1350	parts.
The <i>Paris</i> Foot is	1440	} Of the same parts.
The <i>Rhein</i> or <i>Leyden</i> Foot	1390	
The <i>Boulogne</i> Foot	1686	
The <i>Brace</i> of <i>Florence</i>	2580	
The old <i>Rom.</i> Foot in the Capitol	1306	
According to <i>Ricciolus</i> , it is	1334	

The

The Geometrical Pace contains 5 *Parisian* Feet. 6 *Paris* Feet make a *Toyse*, and 2000 a *Parisian* League, (of which  $28\frac{1}{4}$  makes a Degree) 2853 *Toyfes* is a *Marine* League, 20 to a Degree; 2283 is the Length of an Ordinary League in the Country of *France*, whereof 25 makes a Degree.

'Tis a common Opinion that 5 of our *English* Feet make a Geometrical Pace, 1000 of those Paces makes a Mile: But 1056 Paces, or 5280 Feet makes an *English* Statute Mile.

12 *Rhinland* Feet make a *Perch*, and 1500 *Perches* a Mile.

The *German* Mile, (reckon'd Fifteen to a Degree) contains 24345 *English* Feet, or  $4\frac{3}{4}\frac{6}{10}\frac{9}{10}$  *English* Miles.

An *Italian* Mile, such as are 60 in one Degree, contains 6083 of *English* Feet, or  $1\frac{1}{5}\frac{0}{10}\frac{8}{10}\frac{3}{10}$  of *English* Miles.

The League of *Spain* contains 3400 Geometrical Paces.

The League of *Swedeland* contains 5000 Geometrical Paces.

The League of *Hungary* contains 6000 Geometrical Paces.

The Mile of *Scotland* contains 1500 Geometrical Paces.

Many of our modern Mathematicians, not contenting themselves with uncertain Traditions, have left us their particular Observations concerning the Quantity of a Degree, viz. By

*Fernelius* 68096 Geometrical Paces, which make 56746 *French* *Toyfes* and 4 Feet.

*Snellius* 28500 *Rhinland* *Perches*, which makes 55021 *Parisian* *Toyfes*.

*Norwood* in his Experiment between *York* and *London* found one Degree to contain 367200 Feet, which makes  $69\frac{1}{2}$  *English* Miles.

By the Academy of *Paris* they found the Length of one Degree of a great Circle of the Earth to be 57060 Toyses, according to the Measure of the Chastelet of *Paris*. By this Experiment they counted 15 Feet *Paris*, equal to 16 Feet *London*. (But by Measure in the Tower the *London* Foot being 1200, the *Paris* Foot is 1279. Hence Mr. *Street* supposing 1000 Paces, or 5000 *English* Feet to a Mile, he concluded that 73 such Miles are exactly equal to a Degree.) But according to that Experiment at *Paris*,  $73\frac{1}{2}$  *English* Miles makes a Degree, or  $73\frac{7}{10}$ .

According to which Calculation the Circumference or Circuit of the Earth is  $26293\frac{1}{4}$  fere of *English* Miles.

The Diameter of the Earth is 8369 *English* Miles.

The Surface of the Earth contains 220048209 $\frac{1}{4}$  of Square *English* Miles, containing about 70 Millions of Millions of Acres.

The Solidity of the Earth is 306930160535 $\frac{1}{2}$  fere of Cubick *English* Miles. Which is the solid Content of the Globe of the Earth and Water only, without including in it the Air or Atmosphere which surrounds the Earth.

But if you would also know how much the Air is, you must first find its Altitude, which may be known by observing the divers Refractions of a Star in two different Altitudes of it: By this means the Height of the Air has been found to be near 1000th part of the Semidiameter of the Earth, viz. Near 4 *English* Miles. Having then the Height or Altitude of the Air, you must add the  
Double

Double of it to the Diameter of the Earth and Air in one Orb, *viz.* 309271825484 Cubick Miles to be the solid Content of the Earth and Air together in one Orb; from which if you subſtract the Solidity of the Earth, there remains 2341664949 Cubick Miles, for the ſolid Content of the Air.

So that in the Dimensions of the Earth there are three things to be conſider'd, *viz.* 1. Its Diameter or Circumference. 2. The Extent of its Surface. 3. Its Solidity. If any of theſe be given, the reſt may be readily found: For the Diameter of any Circle is to its Circumference as 7 to 22. So having the Circumference, multiply it by the Diameter, the Product is the ſuperficial Content. This ſuperficial Content multiplied by  $\frac{1}{2}$  of the Diameter, the Product is the Solid Content.

*Of the Scituation of the Earth.*

**T**HE Earth is placed, in reſpect of the other Planets or Stars of the Univerſe, according to *Ptolemy* and *Tycho*, in the Center, fix'd and immovable, and that all the reſt of the Celeſtial Bodies move round it in their Diurnal and Annual Revolutions, as in this Figure. But according to *Copernicus* it is placed between the Orbs of *Mars* and *Venus*, having a two-fold Motion, one Diurnal about its own Center in 24 Hours, whereby all its parts are inlightned, and Day and Night ſucceſſively enjoy'd: The other its Annual Motion about the Sun, whereby all places in courſe enjoy Spring, Summer, Autumn, and Winter. But of the various Motions of the Earth and Planets you may ſee more at large hereafter.

### *Of the Imaginary Parts of the Earth.*

**F**OR the better understanding of the *Terrestrial Globe* (or *Map of the Earth*) in all its external Parts, there ought to be understood and known certain imaginary Lines and Circles, which are not material, but for the better Learning of this Science are supposed to be on or above the *Earth*, viz. 1. Six noted Points, four whereof are Cardinal, viz. *North, South, East, West*. The two other are the *Zenith* and the *Nadir*; the first directly over us, the other under us. 2. Ten Circles or Lines: The *Equinoctial* or *Equator*: The *Tropick of Cancer*: The *Tropick of Capricorn*: The *North Polar Circle* or *Pole Arctick*: The *South Polar Circle* or *Antarctick*: The *Ecliptick* or *Zodiack*: The *Horizon* rational and sensible: *Parallels* or *Circles of Latitude*: *Meridians* or *Circles of Longitude*. The *Axis* or *Diameter*, the extream Points or Ends whereof are called the *Poles* upon which the *Earth* is supposed to move; the one, the *North Pole*; the other, the *South Pole*. 3. Two Colures: The *Equinoctial Colure*, which marks out the *Spring* and *Autumn*, viz. *Aries* and *Libra* marked ♈, ♎. The *Solstitial Colure*, which marks out the *Summer* or *Winter*, viz. *Cancer* and *Capricorn*, marked ♋, ♏.

### *Of the Zones.*

**T**HE Tropicks and Polar Circles divide the Earth into five Parts, called by the *Greeks* *Zones*, from *ζώνη*, *Cingulum*, as enclosing the whole Earth within their respective Districts. Of these  
5 Zones



5 Zones 3 were accounted by the Ancients to be so intemperate as to be uninhabitable ; one of 'em by reason of the Sun's Beams continually darting upon the same ; and this they called the *Torrid Zone*, terminated by the Tropicks on each side. The other two, the one comprehended within the Arctick Circle, and the other compassed by the Antarctick, by reason of extream Cold they thought uninhabitable, as being so remote from the Sun's Beams ; so that only the remaining two were accounted Temperate, and therefore Habitable, the one lying between the Arctick Circle and the Tropick of *Cancer*, and the other between the Antarctick and the Tropick of *Capricorn*.

The Ancients did also distinguish the Inhabitants of the Earth from the Diversity of Shadows of Bodies into three sorts, viz. *Periscii*, *Heteroscii*, and *Amphiscii* : The Inhabitants of the *Frigid Zone* (if any such are) were termed *Periscii*, because the Shadow of Bodies have there a circular Motion in 24 hours, the Sun neither rising nor setting but in a greater Portion of Time.

The Inhabitants of the *Temperate Zones* they called *Heteroscii*, because the Meridian Shadows bend towards either Pole, towards the North among those that dwell within the *Tropick of Cancer* and the *Arctick Circle* ; towards the South among those that dwell within the *Tropick of Capricorn* and the *Antarctick Circle*.

The Inhabitants of the *Torrid Zone* they called *Amphiscii*, because the Noon or Mid-day Shadow, according to the time of Year, doth sometimes fall towards the North, sometimes towards the South ; when the Sun is in the *Northern Signs*, it falleth towards the South ; and towards the North, when in the *Southern Signs*. And because  
of

of the different Site of opposite Habitations, the Ancients have divided the Inhabitants of the Earth into *Periaci*, *Antaci*, and *Antipodes*.

The *Periaci* are such as live under the same Parallel, from the Equator, but in opposite Meridians on the same Parallel. In the *Periaci* of any two Places, the Days in both places are of equal Length, the Seasons of the Year the same, only when 'tis Morning in one 'tis Evening in the other; and when Night at one, 'tis Day in the other.

The *Antaci* are such as have the same Meridian and opposite Parallel, equally distant from the Equator, but the one North and the other South. The *Antaci* their Morning is our Morning, their Noon our Noon, their Night our Night. But their Spring is our Fall, their Summer our Winter, and their longest Day our shortest.

The *Antipodes* are such as Inhabit two places of the Earth which are Diametrically opposite one to the other. With our *Antipodes* all things are quite contrary; for when we enjoy Summer, and the longest Day, then it is Winter with them, and the Days at the shortest: And when the Sun riseth with us, it sets with them; therefore their Morning is our Evening, their Noon our Midnight, &c.

The Ancients did also divide the Earth into *Climates* and *Parallels*.

A *Climate* is a Space or Tract of the Surface of the Earth, bounded by two imaginary Circles, running parallel to the Equator, comprehended betwixt any two places, North and South, whose longest Day differ in quantity half an Hour.

A *Parallel* is a Space of Earth, wherein the Days Increase in Length a quarter of an Hour : so that every *Climate* contains two *Parallels*.

These *Climates* and *Parallels* are not of equal quantity, for the first is longer than the second, and the second likewise greater than the third, &c. At the *Latitude*, where the longest Days are increased half an Hour longer than at the *Equator*, viz. longer than 12 Hours, the first *Climate* begins, which is at the Latitude of 8 Degrees, 34 Minutes ; and in the Latitude of 16 Degrees, 43 Minutes, where the Days are encreased an Hour longer than at the *Equator*, the second *Climate* begins, and so onwards. But because the Ancients, and also *Ptolemy*, supposed that part of the Earth which lies under the Equator to be inhabitable, therefore they placed the first *Climate* at the Latitude of 12 Degrees, 43 Minutes, where the longest Day is 12 Hours  $\frac{3}{4}$  long ; and the second *Climate* to begin at the Latitude of 20 Degrees, 34 Minutes, where the longest Day is 13 Hours and  $\frac{1}{4}$  long, &c.

It's sufficient for our present purpose to tell you, that Modern Geographers reckon, from the Equator to each of the Polar Circles, 24 *Climates* arising from the difference of  $\frac{1}{2}$  an Hour in the longest Day ; and from the Polar Circles to the Poles themselves, are Six arising from an entire Month, the Sun being seen in the first of those a whole Month without setting, in the second two, in the third three Months, &c. unto the Pole it self, where it is 6 Months in Length.

*Of the several Positions of the Earth.*

**F**urthermore in respect of various Phenomena or Appearances of the Celestial Bodies to the divers Inhabitants of the Earth, there is a three-fold Position of the Earth, viz. 1. *Direct*. 2. *Parallel*. 3. *Oblique*.

*Of the Direct Position.*

**T**HE Earth may be so placed, that the Poles thereof may as it were rest upon (or lie directly in) the North and South Points of the Horizontal Circle, neither Pole having any Elevation, the Zenith Point being directly in the Equinoctial Circle, and the Axis of the World directly in the Plain of the Horizon.

This direct Position of the Earth, is particular to those who live under the Equinoctial; as in the Island *Borneo*, *Sumatra*, *Celebes*, &c. in the *East-Indies*. *St. Thomas Island*, and a great part of *Africa*, part of *Peru*, &c. in the *West-Indies*.

In this Position of the Earth, the Sun, Moon, and Stars are always 12 Hours above, and 12 Hours below the Horizon, and consequently make 12 Hours Day and 12 Hours Night. The Sun passing twice over their Heads, every Year is to them twice Vertical, viz. When he is in the Equinoctial Points of *Aries* and *Libra*.

The Inhabitants of the World in this Position can see both the Poles, and behold all the Stars in both Hemispheres to Rise, Culminate, and Set.

The



The End or Extremity of their Gnomons upon their Horizontal Dials, which are our Polar Dials, describe the Figure called *Hyperbole*; except when the Sun is in the beginning of *Aries* and *Libra*, where he describes a straight and right Line. Fig. 4.

*Of the Parallel Position of the Earth.*

THE Earth may be so placed, that one of the Poles shall be in the Zenith, and the other in the *Nadir* Point; that is, either Pole shall be 90 Degrees, or one Quarter of a Circle distant from the Horizon on either side thereof, and the Equinoctial Circle be in the Horizon.

The Earth being in this Position, is said to be Parallel, because the Equinoctial, and all the Parallel Circles, which now are Circles of Altitude, and the Axis of the World, do all of them lie parallel to the Horizon. The Earth is thus posited under both the Poles.

In this Position of the Earth those People (if any be) that inhabit those parts of the World, have but one Day and one Night in the whole Year; from the 10th of *March* to the 13th of *September*, the Sun then being in the Northerly Signs, and consequently on the North side of the Horizon, there is 6 Months Day in the North, and 6 Months Night in the South; and contrarily, from the 13th of *September* to the 10th of *March*, the Sun then being in the Southerly Signs, and therefore on the South side of the Horizon, there is 6 Months Day in the South, and six Months Night in the North.

There is also one kind of Summer and one Winter, when the Sun is above or below the Horizon the whole half-year.



The Gnomon of their Dials (if any be) describe with the Extremity of the Shadow, upon an Horizontal Plain, perfect Circles. *Fig. 5.*

*Of an Oblique Position.*

**I**N this Position our selves, and all other People and Places of the World are, that are not in either of the two former ones: For take any Point, not under the Poles or the Equator for your Zenith, 'twill be impossible to describe an Horizon or Circle 90 Degrees from it, which cuts not the Equator and all its Parallels obliquely: For in this Position, the Axis of the World is neither direct, nor parallel to the Horizon, but lies oblique or slanting from it.

In this Position all the Celestial Bodies, as Sun, Moon, or Stars, have in respect of the Horizon oblique and unequal Ascensions and Declinations, and all the Lines parallel to the Equator, make unequal Angles with the Horizon, and are cut by the Horizon into unequal Parts; for those Lines towards the Elevated Pole, have a greater Portion of a Circle under the Horizon than above it, only the Equator which has the same Center with the Horizon, and therefore divides it, and is divided by the Horizon, into two equal Parts.

Hence follows the great Inequalities in Days and Nights; for when the Sun is in any part of the Ecliptick that declines towards the Elevated Pole, the Days in the Elevated Hemisphere shall be longer than the Nights; and when the Sun is in any part of the Ecliptick, that declines towards the Depressed Pole, the Nights shall be longer than the Days. But when the Sun is in the Equinoctial (whether the Pole be raised or depressed) equal  
Parts

Parts remains, both above and under the Horizon, therefore the Days and Nights are both equal. But by how much the greater the Elevation is, by so much the longer the Days are; and when the whole Horizon falls below some of the Parallels, that then (during the Suns abode there) the Inhabitants have no Night at all; yet notwithstanding this Inequality of Day and Night, all People in all Positions (by that time the Sun finisheth his annual Course) makes them even, and thereby enjoys an equal Share of both; for if in a parallel Position under the Pole, the Sun be six Months under the Horizon, he is as long above it; and if in a right and direct Position, they have always 12 Hours Day, and as much of Night; so we that live in an oblique Site, if our Summer-days be of a mighty Length, our Winter Nights make up the same Dimension. *Fig. 6.*

The real Parts of the Terrestrial or Terraqueous Globe are *Land* and *Water*.

*The Land is divided into*

Two Conti-  
nents.  $\left\{ \begin{array}{l} \text{The Old} \\ \text{The New} \end{array} \right\} \text{viz.} \left\{ \begin{array}{l} \text{Europe, Asia, Afri-} \\ \text{ca.} \\ \text{America.} \end{array} \right.$

A Continent is a great quantity of Land, in which many Kingdoms and Countries are conjoin'd together, and not separated by any Sea.

Many Islands  
in  $\left\{ \begin{array}{l} \text{Europe,} \\ \text{Asia,} \\ \text{Africa,} \\ \text{America.} \end{array} \right\} \text{viz.} \left\{ \begin{array}{l} \text{Great Britain.} \\ \text{Sumatra.} \\ \text{Madagascar.} \\ \text{Hispaniola.} \end{array} \right.$

An Island is a part of the Earth encompassed and environed round with Water.

Some Tracts of  
Lands in parts  
unknown. { *Greenland, Nova Zembla, Nova  
Hollandia, &c.*

Peninsula's. { A part of dry Land almost invironed  
and compassed about with Water, yet  
joyned to the firm Land, as *Africa*  
to *Asia*, the *Morea* to *Greece*.

Isthmus. { Is a narrow Neck of Land be-  
twixt two Seas, joyning the Penin-  
sula to the Continent, as that of *Da-*  
*rien* in *America*, or *Corinth* in *Greece*.

Promontory { A high Hill or part of Land, ly-  
ing out as an Elbow into the Sea, the  
utmost end of which is called a *Cape*,  
as the *Cape of Good Hope* and *Cape*  
*Verde*.

Mountains. { Are higher parts of the Earth than  
the rest which are about it, over-  
topping the adjacent Country, and  
appearing first at a distance; the  
chiefest of which are; in *Europe*,  
the *Alps*, the *Pyrenean*, the *Dofine*  
Hills and *Carpathian Mountains*. In  
*Asia*, *Taurus* and *Imaus*. In *Africa*,  
*Atlas Montes*, the *Christal Moun-*  
tains, *Seirra Leona*, *Table Mount*,  
and the *Pike of Teneriffe*. In *Ame-*  
*rica*, the *Andres* and the *Cordeliars*.

*Of the Water and its Parts.*

The Water on the Surface of the Earth is, by some thought to be more than half the Surface of the Earth, and not above 3 Miles deep, and is divided into

<p><i>Ocean</i> about our Continent viz. in</p> <p><i>The Ocean is</i> a general Col- lection or Ren- derous of all Waters.</p>	<p><i>Asia,</i></p> <p><i>Africa,</i></p> <p><i>Europe,</i></p>	<p><i>Indian</i> or <i>Eastern</i></p> <p><i>Ethiopian</i> or <i>Southern</i></p> <p><i>Northern</i> <i>Frozen or</i> <i>Scythian</i></p> <p><i>Western or</i> <i>Atlantick.</i></p>	<p>containing the Seas of</p>	<p><i>Chinesean, Indian, the</i> <i>Archipelago of La-</i> <i>zaro, Persian, Ara-</i> <i>bick and Ethiopian.</i></p>
				<p><i>Barbary, Zangue-</i> <i>ber, Cassaria, Con-</i> <i>go and Ginea.</i></p>
				<p><i>Norway, Mourmoun-</i> <i>skey More, Petzork-</i> <i>mare Tartary, or</i> <i>Niaren More.</i></p>
				<p><i>Spain and France, cal-</i> <i>led the Bay of Biscay,</i> <i>the English Channel,</i> <i>the British or German</i> <i>Sea, and the high Seas</i></p>
<p><i>Seas</i> about the Continent of <i>The Sea is</i> some particu- lar part of the Ocean.</p>	<p><i>America,</i></p>	<p><i>Mar del Nort,</i> <i>Mar del Zur,</i> or <i>Mare Pacificum,</i> <i>Magellanick,</i></p>		<p><i>New England or</i> <i>Virginia, New Spain</i> <i>or Mexico, Brazil,</i> <i>Peru, California or</i> <i>New Mexico.</i></p>
				<p><i>Paraguay, Megalle-</i> <i>nick and Chilian Sea.</i></p>
<p><i>Inland Seas</i> are part of the Sea, almost en- vironed by the Land.</p>				<p><i>The Baltick, Mediterranean or Levant, Ar-</i> <i>chipelago, Marmora, Euxine, Palus Me-</i> <i>otis, Caspian, Persian, Red Sea.</i></p>



*Gulphs* { *Botknia*, *Finland*, *Riga*, *Dantzick*, *Lubeck*, *Lions*,  
 or { *Venice*, *Lepanto*, *Salonicki*, *Siam*, *Bengala*, *Or-*  
*Bayes.* { *mus* or the *Persian Gulph*, *Hudsons*, *Mexico*,  
*Chesapaick*, *Honduras*, *Panama*, &c. *Delaware*.

*Straits* { *Europe* { *Waygatz* or *Fretum Angliae*, the *Sound*,  
 a narrow part or { the *Belt*, *Gibraltar*, *Dardanel.*  
*Arm of the Oce-* { *Asia* { *Malaca*, *Sanda*, *Manar*, *Bable-*  
*an opening a way* { *mandle.*  
*into the Sea, in* { *America* { *Anian*, *Hudsons*, *Davis*, *Bahama*, *Ma-*  
*gellan*, and *La Maire*.

*Lakes* { *Europe* { *Werner*, *Ladoga*, *Geneva*, *Con-*  
 are such as conti- { *stance*, *Balaton*, *Mayow*.  
*nually keep Wa-* { *Asia* { *Sodom* or the *Dead Sea*, *Astamar*  
*ter, in* { *Africa* { or *Van*, *Burgian*, *Kythay*.  
 { *Zaire*, *Zembre*, *Zastlan*, *Niger*.  
 { *America* { *Canada*, *Mexico*, *Nicaragua*, *Me-*  
*racayba*.

*Rivers*, are *Streams* issuing out of *Fountains*, continually gliding along their *Channels*, until they empty themselves into the *Sea*.

*Note*, The Length of the *Mediterranean Sea* by my new *Globes*, viz. From *Tangeir* to *Scanderon* is not 37 Degrees of the *Equinoctial*; by other *Globes* and *Maps* it is more than 42 Degrees of the *Equinoctial*, which is more than 300 Miles too long. *Note* also, That the Length of the *Caspian Sea* is from N. to S. in my *Globes*; but in others it is E. and W.

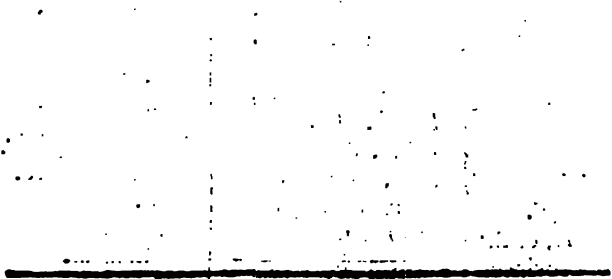
The *Terrestrial* or *Earthly Globe*, is an artificial Representation of the *Earth* and *Water*, under that Form and Figure of Roundness, which they are known to have, describing the Scituations, and measuring the Distances of all their Parts.

The Land drawn out upon a *Globe*, is bounded and distinguished from the *Water* with an irregular Line, which runs turning and winding into *Creeks* and



and Angles, like as the Shoar which it represents : that side which is left uncoloured, is the Limits of the Water ; the other side of the Line which encircles the Colours, is the Bounds of the Land.

The Land drawn upon the Superficies of the *Terrestrial Globe* , is divided in four principal Parts or Quarters, viz. *Europe, Asia, Africa, and America.*



## Of EUROPE.

Europe as it is now divided, contains these

Kingdoms or States.	Cities.	Rivers.
England & Wales.	London, Canterbury, York, Oxford, Cambridge, Bristow, Cardiffe, Welshpool.	Thames, Severn, Humber, Trent, Wye, Usk.
Scotland.	Edenburgh, St. Andrews.	Tweed, Forth, Tay.
Ireland.	Dublin, Waterford, Galloway, Limerick.	Shannon, Shure, Blackwater, Barrow
France.	Paris, Lions, Orleans, Bourdeaux, Tbolouse, Aix.	Seine, Loire, Garone, Rofne.
Spain.	Madrid, Siville, Toledo, Saragoffe.	Ebre, Gaudalquivir, Gaudiana, Douro.
Portugal.	Lisbon, Braganza.	Tagus.
Belgia, or the 17 Provinces.	Amsterdam, the Hague, Antwerp, Brussels.	Meuse, Ifel, Lis, Eschant.
Italy.	Rome, Florence, Venice, Naples, Genua, Milan.	Po, Arne, Tiber, Adige.
Savoy.	Chambery, Turin.	Doire, Lifire,
The Swiffes.	Geneve, Bazil, Zurich.	Rus, Aar.
Denmark.	Copenhague, Sleswick, Bergen, Christiane.	Sley, Eyder.
Sweden.	Stockbolm, Gottenburg, Upsal, Calmer.	Wenar, Veter.
Poland.	Cracovia, Dantzick, Vilna, Warzovia.	Duna, Neimen, Vistula, Neiper, Neister, Bog.
The Empire of Germany with Huugary.	Vienna, Nuremberg, Hambrough, Prague, Collen, Heidelberg, Buda.	Danube, Elbe, Rhine, Vefer, Oder, Teifs.
Ruffia.	Moscow, Novogrod, Arch-Angel, Smolensko.	Wolga, Dwina, Oby, Tanais, Boristenes.
Turky in Europe.	Constantinople, Belgrade, Adrianople, Saloniche.	Danube, Dravus, Savus, Tebiscus.
Little Tartaria	Kers, Cassa, Azof.	Tanais now Don.
Islands.	Great Britain, Ireland, Wight, Man, Zeeland, Candia, Sicily, Sardinia, Negropont, Cefalonia, Zant, the Helrides, Orcades, Azores, &c.	

of

Of ASIA.

Asia as it is now divided, contains these

Empires or Countries.	Cities.	Rivers.
The Turkish Empire.	{ Aleppo, Smyrna, Bursa, Damascus, Jerusalem, Bagdat, Mosul, Cogni:	Tigris, Jordan, Euphrates, Menander.
Georgia.	Fazo, Teflis.	Fazis, Kur.
The Arabia's.	{ Mecca, Medina, Anna, Mocha.	Chaiber, Nageran.
The Persian Empire.	{ Isfahan, Casbin, Tauris, Syros, Ferrabat, Herat.	Teus, Pulimalon. Isment, Brandimer Araxes, Euleus.
The Mogul's Empire.	{ Agra, Labor, Delli, Amadabat, Cambaja, Surrat.	Indus, Ganges. Jemina, Ravoe.
India within Ganges.	{ Goa, Calicut, Cochin, Nagapatan, Narsinga, Golconda, Mazulpatan.	Guenga.
India without Ganges.	{ Pegue, Sian, Mallaca, Cambodia.	Pegu, Cosmin. Ava, Martaban.
Tartary in Asia.	{ Astracan, Samarchand, Tobol, Albazin, Balch.	Oxas, Chefel, Lena Obey, Genofca.
China,	{ Pekin, Canton, Nanking, Hanchen.	Croceus, Ta, Kiang.
Japan.	{ Meaco, Jedo, Firando, Nangasacque.	
Oriental Islands.	{ The Maldives, Ceylon, Sumatra, Java, Bor- neo, Celebes, the Philippines, the Molucces and Ladrons.	
Mediterranean Islands,	Cyprus, Rhodes,	Peliculus R.
In the Archipelago,	Metellino, Scio, Samos, Nicaria, &c.	

Of

## OF AFRICA.

*Africa* as it is now divided, contains these

Parts or Countries.	Cities or principal places.	Rivers.
Barbary.	{ Fez, Morocco, Salley, Tanger, Alger, Tunis.	Suba, Tenlis, Sus, Omiraby, Guadi- barber.
Egypt.	{ Cairo, Alexandria, Rossette, Damietta.	Nilus.
Biledulgerid.	{ Segelmess, Taradant, Biledulgerid, Dara.	Ghir, Major, Ziz,
The Desarts of Sarra.	{ Zambaga, Zuenziga, Terga, Lempta, Berdoa.	Ghir, Nubie.
The Land of the Blacks.	{ Tombolu, Agades, Borno, Zanzara.	Niger, Senega, Gambia, Grande.
Kingdom of Nubia.	{ Nubie, Jalac, Dancala,	Nilus, Ghir.
Guinee.	{ S. George de la Mine, Cape Cors, Settera, Benin.	Sweiro, Volta, Calabar, Benin.
Æthiopia, or Habessina.	{ Ambacel, Auxumo, Gesben, Arquica.	Nilus, or Abavi, Hawash, Tacaze.
Congo.	St. Salvador, Dongo.	Zair, Coanza, Coango.
Mono Emugie	Chicova, Fort Martail.	Zambeze.
Monomotapa	{ Monomotapa, Butua, Zimbaoe.	Cuama.
Caffares.	{ Sofala, Cape of Good- Hope.	Spirito Sancto, Rio d'Infanta.
Zanguebar.	{ Mosambique, Quiloa, Mombaza, Melinde.	Zambeze, Cuame,
Adel.	{ Auc, Agurele, Zeila, Doa- ra, Adea, Magadoxo.	Magadoxo, Doara, Quilmenai.
Islands.	{ The Maderas, Canaries, Cape Verde, St. Helena, Madagascar, Zabelmandel, Zocatora, Malta, St. Thomas, Princes, &c.	

of

Of AMERICA.

*America* as it is now divided, contains these

Parts or Countries.	Cities or principal places.	Rivers.
The Coast of the N. W. passage.	{ Carlton Island, Fort Charles.	Pr. Rupert's River.
Canada, or Nova Francia.	{ Quebeck, Brest Hurons, Port-royal.	Canada.
New Engl. & New York.	{ Boston, Plymouth, New York, Milford.	Hudsons, Connecticut, Marimack, Piscataway.
Maryland and Virginia.	{ St. Maries, James Town.	James, York, Patomeck, Rapahanok.
Carolina and Florida.	{ Charles Town, St. Matthew.	Albemarle, Ashly, Messasipy R. Cooper
New Mexico.	New Mexico.	R. del Norte.
New Spain.	{ Mexico, Valadolid, St. Jago, Gaudalajara.	Panuco, Barania, Qacatulca, Sal.
Castilladel, or	{ Panama, Porto Bello, Cartagena, St. Martha.	St. Martha.
Guiana.	{ Manoa, St. Thome.	St. Magdalen.
Perue.	{ Lima, Casco, Potosi, La plata.	Oronoq; Surinam.
Chili.	{ St. Jago, Imperial, Baldivia.	Wiapoca.
The Country o'th' Amazons.	{ Homagus, Torimans, Topinambes, Coropa.	Maragnon.
Paraguay.	{ Buenos Ayres, Cuidat Real, St. Jago, Estero.	Parinie.
Brazil.	{ Pairaba, Pernambuco, S. Salvador, Spir. Sancto.	Copayapo.
Pensilvania & New Jersey.	{ Philadelphia, Perth Town.	Topacalma, Amazons.
Islands	{ Hispaniola, Cuba, Jamaica, New-found-land, the Caribbee-Islands, Long-Island, Magellan-Island, Bermudas, Port-rico, California.	Rio de plata. Perana. Grande, S. Francisca. Ilheos, Janiero. Susquahannah, Delaware, Rariton.

And



And thus much shall serve for the Description of the Land upon the *Terrestrial Globe*.

Now that all Places, Cities, Towns, Seas, Rivers, Lakes, &c. may be readily found out upon the *Globe*, all *Geographers* do, or should place them according to their *Longitude* and *Latitude*; the use of which in the absolute Sense, is to make out the Position of any place in respect of the whole *Globe*, and to shew the Situation and Distance of one place from, and in respect of any other.

#### An Advertisement concerning *Longitude*.

**T**O say the Truth, by reason of the Variety of Meridians, the Longitudes are grown to such an uncertainty and confused pass, that 'tis not every Man's Work to set them down. This indeed I have observed, that many *Geographers*, or rather Describers of particular Places, tell us that such a place is so many Degrees of Longitude; but from what Meridian, others must guess. Some particularly profess to follow Mercator: But what are most Men the wiser for this? for Mercator's Meridian was not always the same; sometimes through the Canary-Islands, sometimes through the Azores. Others again will tell you their Meridian shall pass through the Azores; but whether from that of St. Michael, or that of Corvo, is not set down; and yet 6 deg. of difference. I shall therefore take this Course: First set down the several Meridians observed. Secondly, the difference of Longitude betwixt these Meridians. Lastly, which of these I have fixt upon.

#### 1. The

1. The *Great Meridian* by *Ptolemy*, and most of the ancient and Greek *Geographers*, was made to pass through *Junonia* one of the *Fortunate Islands*, now thought to be the *Canary Islands*, or rather *Cape Verd Island*.

2. By the *Arabian* and *Nubian Geographers*, through the utmost point of the *Western Shore*, near *Hercules Pillars*, supposed to be *Cape Cantin*.

3. *Ortelius* in his *Sheet-Europe* makes *London* to lie in 28 deg. of *Longitude*; but in the *Sheet-Maps* of *France* and *Belgia* it lies in but 21 deg. so that his first *Meridian* to me is uncertain. The *Spaniards*, since the *Conquest* of the *West-Indies*, contrary to all other, account their *Longitude* from *East* to *West*, beginning at *Toledo*.

4. Our modern *Geographers*, as *Mercator*, *Cámbden*, *Speed*, and others, removed it into the *Azores*; some placing at *St. Michael's*, others at *Corvo*.

5. *Blaew* the *Dutch Geographer*, begins his *Longitudes* from *Teneriff* one of the *Canary Islands*; but upon his *Great Map*, the *Great Meridian* passeth through *Tercera Isle*, one of the *Azores*; which the rest of their common *Map-makers*, *De Wit*, *Visser*, &c. as well as many of our *English*, are bound to follow through *Ignorance*, transcribing as well his *Errours* as his *Copies* for the best.

6. *Sanfon* and other *French Geographers*, for some *Reasons* (best known to themselves) begin their *Longitudes* at *Ferro* one of the *Canary Islands*; and therefore their *Translators* are bound to follow it, though possibly they cannot tell so much, and yet gear *Pretenders* to *Geography*.

7. The English *Hydrographer* in the use of his Globe, tells us, that with a great deal of Reason and Consideration he placed his first *Meridian* at *Graciosa* one of the Islands of the *Azores*; but it is delineated upon his *Globes* and *Maps* through *Tercera*, almost 2 deg. more *Eastward*: a small Mistake, that another must come after him to tell himself what *Meridian* he went by.

I do not mean a late Upstart *Hydrographer*, who never did, nor ever knew how to project or draw a *Map* or *Sea-Chart*, much less to make *Globes*; yet has the Confidence to publish Proposals for the making up of *Large Globes*, and that with much Ostentation and Boasting, to the Abuse and Cheating some worthy Gentlemen; who perhaps are more enclined to encourage ingenious Undertakings, then to enquire and be satisfied of the Honesty and Ability of bold and ignorant Pretenders.

Secondly, The differences of these several *Meridians* I find are thus stated.

From *Ptolemy's Meridian* to the *Arabian Meridian*, was by *Abulfeda* in his Introduction to his *Geography*, accounted to be 10 deg. *Briet* saith but 8 deg.

		d. m.		
From the Pico of Tenerife to	Toledo	15	15. 55. the Spanish	Meridian.
	Graciosa		10. 25. the mistaken Engl.	
	Tercera		9. 0. the supposed Dutch	
	Palma or Ferro		2. 20. the French	
	Corvo		13. 25. } Mercator and	
	St. Michael		8. 5. } others.	

And this last is the *Meridian* from which the *Longitudes* are reckon'd in that *Terrestrial Globe* of

of about 15 Inches Diameter, set forth by Robert Morden some years since, which are the latest, and more exact and correct, than those trifling old Toyes, sold and made up (rather marred) by the aforesaid Hydrographer.

## Geographical Problems.

### PROB. I.

To find the Longitude of any Place described on the Globe.

**L**ongitude is the Distance of a Place from the first Meridian, reckon'd in the Degrees of the Equator, beginning, as was said, in this new Terrestrial Globe, at St. Michael's Island in the Azores.

*Practice.*] Bring the Place (that is, the mark of the Place) suppose London, to the Brazen Meridian; then count how many Degrees of the Equator, are contained between the first Meridian and that of London, cut by the Brazen Meridian, which you will find to be 28 deg. and that is the Longitude required. And in this manner you shall find

		d.	m.
London	} to be distant from the first Meridian by this New Globe.	28	0
Jerusalem		66	30
Fedo in Japan		167	0
Rio de la plata		327	0
Mexico		284	30
Charlton Isle		206	30
	Cc		By



	d.	m.	
By other Globes and Maps	26	0	reckoned from the same Meridian.
	73	30	
	178	0	
	336	00	
	278	00	
	292	00	

## P R O B. II.

To find the Latitude of any place.

**T**HE Latitude of a place, is the distance of the Equator from the Parallel of that place, reckon'd in the Degrees of the Great Meridian; and is either North or South, according as it lies between the North or South-poles of the Equator.

To find the Longitude. Bring the mark of the Place, for Example, suppose London, to the Brezen Meridian; then count the number of Degrees upon the Meridian, contained between the Equator and the place given. Thus you shall find the Latitude of London to be 51 d. 30'.

And	d.	m.		d.	m.
Labor in the Mogul's Country to be	31.	30	By o- ther Globes and Maps.	23.	30
The South-part of the Caspian Sea to be	37.	0		41.	0
Astracan, on the Nor. part of the Caspian Sea to be	46.	0		49.	0
The North part of China to be	42.	0		52.	0
Delli in India to be	28.	0		21.	0
Constantinople to be	41.	0		43.	0

PROB.



P R O B. III.

*The Longitude and Latitude of any place being known, to find the true Scituation of it, though not expressed upon the Globe.*

**B**Ring the Degree of the *Equator*, that answereth to the *Longitude* of the place, to the *Brass Meridian*, and then reckon the *Latitude* of the place upon the Degrees of the *Meridian* towards either *Pole*, according as it hath either *North* or *South Latitude*; and right under that Degree and Minute upon the *Meridian*, is the true Scituation of the Place enquired after.

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P R O B. IV.

*To find what Time or Hour of the Day or Night it is, in any part of the Earth.*

**B**Y reason of the Earth's Diurnal Motion round the *Sun* in 24 Hours, the *Sun* enlightning but one half of it at the same time, it comes to pass that when it is Morning in one place, it is Noon in a second, Night in a third, and Midnight in a fourth, according to their several Scituations, in respect of *East* and *West*, one from the other. This difference of Time, is known by the number of Degrees, contained in the *Equator*, between any two places proposed, converted into Hours and Minutes, reckoning 15 deg. to an Hour, &c. but more readily by the *Globe* thus :

*Practice.*] Suppose at *London*, at Twelve of the Clock at Noon, you would know what a Clock it is at *Mexico* in the *West-Indies*; bring *London* to the Meridian, and set the Index of the Hour-Circle to 12. then turn the *Globe Eastward*, because *London* is East of *Mexico*, till you bring *Mexico* to the Meridian; then see what hour the Index points at, for that is the Hour then at *Mexico*; and thus you shall find

		<i>h.</i>	<i>m.</i>	
When it is 12 a Clock at <i>Lon-</i> <i>don</i> , it is at	<i>Mexico</i>	5	10	} a Clock before
	<i>Charlton Island</i>	6	45	
	<i>Rio de la plata</i>	8	10	} Noon.
	<i>Jerusalem</i>	2	35	
	<i>Surrat</i>	5	15	} a Clock after
	<i>Fedo</i>	9	18	

And thus, by knowing what difference of time there is, between place and place at 12 a Clock, the like difference is to be understood of all other hours.

### P R O B. V.

*To find the distance of any two places, howsoever situate in respect of Longitude and Latitude upon the Globe one from another.*

*Præfice.* **L**ay the *Quadrant of Altitude* upon both the places required; then count the number of Degrees of the *Quadrant of Altitude* contained between the two places: which being found, multiply them by 60, gives the

the distance in English Miles. Thus you will find

The distance of London from		d. m.		by our new size of Globes.	d. m.		by the great Dutch Globes and English
		Mexico	81.30		91.30		
		Jerusalem	33.30		38. 0		
		Surrat	65.50		71.40		
		Jedo	85.10		92.30		
		Rio de la plata	100.20		106. 0		
		Charlton Island	46.20		54. 0		

If you find (as you needs must) that the Proportion of Miles, upon these new *Globes*, do very much differ from those Distances set down by other Authors, you are desired not to think much; for the *Longitudes* are not yet exactly agreed on: the Perfection is not one Man's, nor one Ages Work, and must be waited for. Where you find the places upon this *Globe* to agree with others, you have cause to suspect they have lain upon the Lees of Time, not as yet inquired into: where you find them to disagree, you may conclude, that they have been brought to a truer Correction and Amendment,

# P R O B. VI.

To find the Position, or what Point of the Compass any two places are situate one from another.

THE Position is an *Angle*, which is made by the meeting of the *Meridian* of one place, with the *Vertical Circle* of another.

To find this out, you are to elevate the *Pole* to the *Latitude* of one of the places, suppose *London*; then bring it to the *Meridian*, and it will fall out to be directly in the *Zenith*, for the *Elevation* is always equal to the *Latitude*; then fasten the *Quadrant of Altitude* to the *Zenith*, and turn it about till it fall upon the other place, suppose the *Isle of Tenerif*, and the end of the *Quadrant*, where it toucheth the *Horizon*, will shew that the *Isle Tenerif* beareth from *London* S. S. W. so also the bearing of *Barbadoes* from the *Lizard* to be S. W. half a Point Westerly; and the opposite Point N. E. half a Point Easterly, the bearing of the *Lizard* from the *Barbadoes*.

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#### P R O B. VII.

To know at any time in what place of the Earth the Sun is in their *Zenith*.

This must be to such Inhabitants of the Earth only that inhabit in the *Torrid Zone* between the *Tropicks*: For the Sun is never in the *Zenith* of any People, inhabiting either in the *Temperate* or *Frigid Zones*.

Bring the place you are in, suppose *London*, to the *Meridian*, and the *Index* to the hour 12; then consider the time of the Day, which suppose to be half an Hour after 5 in the Afternoon, the Sun having then 10 Deg. of *North Declination*: then because it is Afternoon, turn the Body of the *Globe* Eastward, till the *Index* hath passed 5 hours and  $\frac{1}{2}$ , from 12, that will be to 7 a Clock and  $\frac{1}{2}$ , and there stay the *Globe*; then see what Place or Country



Country is under the *Meridian* that cuts 10 deg. of *North Declination*, and you will find *Nombre di dios* upon the *Isthmus* of *Panama* in the *West-Indies*. But if it were required the same day, at half an hour after 6 in the Morning, then you should have turned the *Globe* Westward, till the *Index* had passed 6 hours and  $\frac{1}{2}$ ; and then under the *Meridian*, and upon the Parallel of 10 Deg. North-Declination, you will find it near 4 or 5 little Islands close by the *West-side* of *Mallacca* in the *East-Indies*, where the *Sun* will be in their *Zenith* at that time.

Having found in what place of the Earth the *Sun* is in the *Zenith*, elevate the *Globe* to the *Latitude* of that place either North or South; then bring that place to the *Meridian*; so shall all places cut by the *Horizon*, have the *Sun* in their *Horizon*; those to the Westward shall have the *Sun rising* in their *Horizon*; those to the Eastward shall have the *Sun setting*. In those Countries that are above the *Horizon*, it is Day-light, and in those it is 18 deg. below the *Horizon*, it is Twilight; but in those Countries further below the *Horizon*, it is at that time Midnight.



## P R O B. VIII.

*The difference of Longitude being known, to find what Degree of the Ecliptick culminates, at any other place at any time proposed.*

*March the 10th at 10 of the Clock before Noon here at London, I would know what Degree of the Ecliptick culminates then at Jerusalem.*

**E**levate the *Globe* to the *Latitude* of your place, viz. 51. Deg. 30 min. then bring the *Suns* place for that Day, viz.  $\gamma$  0 deg. to the *Meridian*, and the *Index* to 12. then turn the *Globe Eastward*, till the *Index* point at the given Hour, viz. Ten of the Clock, and you will find the 28 deg. of  $\pi$  then culminating here at *London*. Next turn about the *Globe Westward*, until 33 deg. 30 min. of the *Equator* be passed through the *Meridian*, or till the *Index* of the Hour-circle be moved 2 Hours 35 min. which is the difference of *Longitude* given, and then you will find the *Meridian* cut the *Ecliptick* at almost 4 deg. of  $\gamma$  : so that I say,  $\gamma$  4 deg. is the Point of the *Ecliptick* that is then culminating at *Jerusalem*.

## P R O B. IX.

*To find out the several Positions of the Inhabitants of the Earth, the Distinction of Shadows, the different Habitations, &c.*

**T**HE *Longitude* and *Latitude* of a place once resolved on, the *Position* of the *Sphere* you cannot .

cannot miss of; for if the place you try for have no *Latitude*, it must of necessity lie under the *Equator*; and therefore in a *Right Position*: If it have less or more *Latitude*, the *Position* is Oblique; if the place have 90 deg. of *Latitude*, the *Position* is Parallel: the Reasons were told before, and may evidently be discerned upon the *Globe*.

For the Climes and Parallels, and consequently the length of the longest Day, the foreknowledge of the *Latitude* leadeth you directly; for they who are under the *Equator*, have their Day always 12 Hours, and their Night 12 Hours long. Now as each Country declines from the *Equator* towards either of the *Poles*, so the Days vary their Length in Summer, and the Nights theirs in Winter: according therefore to the different Lengthening of their Days, the Ancients did distinguish the Earth into several Portions or Parts, which they called Climates and Parallels: every Clime contains two Parallels; so that where the longest Days are half an hour longer than at the *Equator*, the first Climate begins; and where they are encreased an Hour longer than at the *Equator*, the second Climate begins, which by the 20th *Problem* you will find to be at 8 deg. 34 m. for the first, and at 16 deg. 43 m. where the second begins; and so for any of the rest.

The *Tropicks* and *Polar Circles*, divide the Surface of the *Globe* into 5 Parts or Spaces, which are called *Zones*, whereof one is contained within the *Arctic Circle*, another compassed by the *Antarctic Circle*, and are called the *Frigid Zones*; the other two lying between the *Arctic Circle* and *Tropick of Cancer*, and between the *Antarctic Circle* and the *Tropick of Capricorn*, are called the *Temperate Zones*; and the other lying  
between

between the two *Tropicks*, is called the *Torrid* or *Mid-zone*.

Knowing these, you may easily conclude upon the Distinction of Shadows: for those of the *Frigid Zones* are termed *Periscii*, because there their Shadows have a Circular Motion. Those of the *Temperate Zone* are called *Heteroscii*, because their *Meridian* Shadows bend towards either *Pole*; towards the *North* to those that dwell within the *Tropick* of *Cancer*, and the *Arctick Circle*; towards the *South* to those that dwell within the *Tropick* of *Capricorn* and the *Antarctick Circle*. The Inhabitants of the *Torrid Zone* were called *Amphiscii*, because the Noon-shadows, according to the time of the Year, do sometimes fall towards the *North*, when the *Sun* is in the *Southern Signs*, and sometimes towards the *South*, when the *Sun* is in the *Northern Signs*.

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### P R O B. X.

*To find out the other Distinction of Habitation, viz. Antaci, Periaci, Antipodes.*

**L** Et *London* be the place; bring it to the *Meridian*, where you find it to be 51 deg. 30 min. elevated above the *Equator*, account so many Degrees of *Southern Latitude* below the *Equator*, and you meet with the *Antaci* (if any be.) Remove *London* from the *Meridian* 180 deg. and you shall find your *Periaci*, under the *Meridian* where *London* was before, and your *Antipodes* is in the place where their *Antaci* stood before.

P R O B,

P R O B. XI.

*The Hour of the Day given, to know what a Clock it is, in any other place of the Earth.*

**T**HE Globe elevated to the Latitude of the Place, bring that place to the Brazen Meridian, and set the Index of the Hour-Circle to the Hour given; then turn the Globe either Eastward or Westward, according to its Situation, until the other place required come to the Brazen Meridian, and the Index will point to the Hour of the Day at that place.

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P R O B. XII.

*The Hour of the Day given at any one place, to know what places of the Earth to which the Sun is in their Meridian at that time.*

**E**levate the Globe to the Latitude of the given place, which bring to the Brazen Meridian, and set the Index of the Hour-Circle to the Hour given; turn the Globe about, till the Index point at the upper Figure XII. which done, observe what places are exactly under the Eastern Side of the Brazen Meridian; for those are the places required.

P R O B.



## P R O B. XIII.

*The Latitude and Sun's place given, to know the Length of the Day and Night in any place of the Earth.*

**E** Levate the Globe to the Latitude of the place given, find the Sun's place in the Ecliptick, *p. 1.* which bring to the East side of the Horizon; and then set the Index of the Hour-Circle to the North or South XII. then turn the Globe about, till the aforesaid Sun's place, comes to the Western side of the Horizon. Then observing upon the Hour-Circle (during the Revolution of the Sun's place from E. to W.) the number of Hours that Index has passed is the Length of the Day, the Complement thereof to 24 is the Length of the Night. *Vide Prob. IX.*

## P R O B. XIV.

*The Latitude and Sun's place given, to find the time of the Sun's Rising and Setting in any place.*

**T**HE Globe elevated to the Latitude, bring the Sun's place to the Meridian, and the Index to XII. at Noon; turn the Globe Eastward, till the Sun's place touch the East-side of the Horizon; then will the Index point, upon the Hour-Circle, the time of Sun-rising: Then turn the Globe Westward, till the Sun's place touch the West-side of the Horizon, then shall the Index point at the time of Sun-setting. *Vide Prob. VIII.*

*Note,*



*Note,* These foregoing Problems are not exact in respect of all places, although never taken notice of by any Author that has written of the *Use of the Globes*.

For admit a place in the *West-Indies* 60 deg. of Longitude from *London*, and it's Latitude 10 deg. N. it is demanded, whether the Sun riseth with them just 4 Hours after it doth with us. No, but the Sun riseth with them, when in the Summer Tropick, viz. ☊, 6 Hours after it doth with us, that is, he doth not rise with them till it be 46 m. after 9 of the Clock, which is 6 Hours after 3 h. 4 m. the time of his rising with us, our 9 h. 46 m. answering to their 5 h. 43 m. But the Sun comes to their Meridian just 4 Hours after it doth with us, that is, when it is 4 with us, it is 12 with them, and the contrary.

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P R O B. XV.

*To know by the Globe when the Great Turk, the Great Mogul, or the Czar of Muscovy, Rise, Dine, and go to Bed.*

**T**HIS we may easily do, at what time soever it be, or wheresoever we are: For finding by the foregoing Problem, the present Hour of the Day, Time of Sun Rising and Setting in *Constantinople*, *Agra*, and *Moscow*, the Imperial Seats of those mighty Monarchs, we may readily determine how near it is to the time desired.

P R O B.

## P R O B. XVI.

*The Longitude and Latitude of any Place being given, to find all those Places that have the same Longitude and Latitude.*

**B**Ring the Place proposed to the Brazen Meridian, and draw a Line, or observe what places are cut by the graduated Plane of the upper side of the Meridians; for all those places just under it have the same Longitude: Also observing the Latitude at the same time, make a Mark upon the Meridian, then turning the Globe round, all those Places passing under the said Mark, have the same Latitude with the given Place.

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## P R O B. XVII.

*The Day of the Month, and Hour of the Day given, to find those Places on the Globe, to which the Sun is in their Meridian at that time.*

**T**HE Globe elevated to the given Latitude of the Place, bring the said Place to the Brazen Meridian, and set the Index of the Hour Circle to the given Hour; then turn the Globe till the Index point to the upper Figure of XII. then fix the Globe; and see what Places are under the upper Hemisphere of the Brazen Meridian, for those are the Places required.

P R O B.

P R O B. XVIII.

*The Latitude of the Place, and Height of the Sun given, to find thereby the Hour of the Day,*

**E** Levate the Globe to the Latitude of the Place given, then find the Sun's Place in the Ecliptick by *Prob. 1.* which bring to the Brazen Meridian, and put the Index of the Hour-Circle to XII. then fix the Quadrant of Altitude in the Zenith, and mark, in the said Quadrant, the particular Degree of the Sun's Altitude, move the Globe with the Quadrant of Altitude, till the Sun's place marked in the Ecliptick, and his Degree upon the Quadrant of Altitude do both meet together; then observe what Hour the Index doth point at, for that is the Hour desired.

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P R O B. XIX.

*The Hour of the Day being given, according to our way of reckoning in England, to find thereby the Babylonick Hour at any time.*

**T**HE *Babylonick Hour* is the number of Hours from Sun rising; it being the manner of the *Babylonians* of old, and the *Inhabitants of Norimberg* at this Day, to commence their Hours from the appearance of the Sun in the Eastern Horizon. For the finding of this Hour at any time, and in any place, first elevate the Pole to the Latitude of the given Place, and noting the Sun's Place

Place in the Ecliptick at that time, bring the same to the brazen Meridian, and set the Index of the Horary Circle at Noon; after this move the Globe either *Eastward* or *Westward*, according to the time of the Day, till the Index point at the given Hour. Then fix the Globe in that Position, and bring back the Index again to Noon, and move the Globe from West to East, till the *Sun's* Place mark'd in the Ecliptick, coincide with the Eastern Horizon; which done, reckon upon the Hour Circle the number of Hours between the Index and Noon (or the upper Figure of 12.) for that is the number of Hours, from Sun-rising for that Day, in the given Place, or the true *Babylonick Hour* desir'd.

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P R O B. XX.

*The Babylonick Hour being given, to find the Hour of the Day at any time, according to our way of reckoning in England.*

**E** Levate the Pole according to the given Latitude of the Place, and marking the Sun's Place in the Ecliptick, bring the same to the brazen Meridian, and set the Index of the Horary Circle at Noon. Then move the Globe Westward, till the Index point at the given Hour from Sun rising, and fixing the Globe in that Situation, bring the Index back again to Noon, and turn the Globe backwards, till the Sun's place mark'd in the Ecliptick, return to the same Semi-circle of the brazen Meridian from whence it came; which done, observe what Hour the Index of the Horary Circle pointeth at, for the same is the Hour desir'd.

P R O B.



P R O B. XXI.

*The Hour of the Day being given, according to our way of reckoning in England, to find thereby the Italick Hour at any time.*

**T**HE *Italick Hour* is the number of Hours from Sun setting at all times of the Year, to Sun setting the next following Day. For the ready finding of such Hours, elevate the Pole according to the Latitude of the Place, and noting the Sun's place in the Ecliptick, upon the given Day, bring the same to the brazen Meridian, and set the Index of the Horary Circle at Noon. Then turn the Globe either East or West, according to the time of the Day, till the Index point at the given Hour, and fixing the Globe in that Situation, bring the Index back to Noon. Which done, turn the Globe about Eastwards, till the Mark of the Sun's place in the Ecliptick coincide with the Western Horizon, and observe how many Hours there are between the upper Figure of 12. and the Index (reckoning them Eastward as the Globe moved) for these are the Hours from Sun-set, or the *Italick Hour* desir'd.

P R O B. XXII.

*The Italick Hour being given, to find thereby the Hour of the Day at any time, according to our way of reckoning in England.*

**T**HIS being the Reverse of the former Problem, elevate the Pole according to the Latitude  
D d of



of the given place, and noting the Sun's place in the Ecliptick, bring the same to the Western Horizon, and setting the Index of the Horary Circle at Noon, turn the Globe Westward, till the Index point at the *Italick Hour* given; then fixing the Globe in that Position, bring the Index back to Noon, and move the Globe backward, till the Mark of the Sun's place, return to the same Semi-circle of the brazen Meridian from whence it came. Which done, observe how many Hours are between Noon and the Index, (reckoning them from West to East) for those are the Hours desir'd, according to our way of reckoning in *England*.

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### P R O B. XXIII.

*The Hour of the Day being exactly given, according to our way of reckoning in England, to find thereby the Judaical Hour at any time.*

**B**Y the *Judaical Hour*, we understand the exact Time of the Day, according to the ancient *Jews*, who in reckoning their time, divided the Artificial Day into twelve Hours, and the Night into as many, which Hours prov'd every Day unequal in Extent (unless in Places exactly under the Equator) they still decreasing or increasing according to the Seasons of the Year, or the various Declination of the Sun. For the finding of which Hours, observe the following Method: Elevate the Pole according to the Latitude of the given Place, and marking the Sun's Place in the Ecliptick at that time, bring it to the Eastern Horizon,

rizon, and set the Index of the Horary Circle at Noon; then turn the Globe about, till that place mark'd in the Ecliptick come to the Western Horizon, and observe the number of Hours between Noon and the Index, these being the Hours of which the given Day doth consist, which number you are to note down, and to find what Hour from Sun-rising corresponds with the given Hour, or from Sun-setting, if the given Hour be after Sun-setting. Which done, work by the following Proportion. As the number of Hours, whereof the given Day consisteth, (*viz.* those noted down) is to 12; so is the number of Hours from Sun-rising, (if it be an Hour of the Day) or from Sun-setting (if an Hour of the Night) to a fourth Proportional, which is the number desir'd, *viz.* the *Judaical Hour* at the time given.

P R O B. XXIV.

*The Judaical Hour being given, to find thereby the Hour of the Day at any time, according to our way of reckoning in England.*

**E** Levate the Pole according to the Latitude of the given Place, and finding the Sun's Place in the Ecliptick at the time given, bring the same to the Eastern Horizon, and set the Index of the Horary Circle at Noon, then turn the Globe Westward, till the Sun's Place coincide with the Western Horizon, and the Index will point at the number of equal Hours whereof that Day consisteth. Which number you are to note down, and bring the Sun's Place to the brazen Meridian, and setting the Index again at Noon, turn the Globe  
D d 2 about

about, till the Sun's Place coincide with the Eastern Horizon, and the Index will point at the Hour when the Sun riseth in the given Place. Which done, work by the following Proportion. As 12 is to the given Number of *Judaical Hours*, so is the Length of the Day in equal Hours (formerly found out) to a fourth Proportional, which is the number desired, *viz.* the Hour of the Day according to our way of reckoning in *England*. Only note, That if the fourth Proportional be less than 12, you are to add the same Number of Hours before Noon for that Day; but if it be more than 12, then subtract it from 12, and the Remainder will give the Hour of the Day for the Afternoon.

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## P R O B. XXV.

*A Place being given on the Globe; to find those which have the same Hour of the Day with that in the given Place, as also that have the contrary Hours, i. e. Midnight in the one, when it's Mid-day in the other.*

**B**Ring the given Place to the brazen Meridian, and observe what Places are then exactly under that Semi-Circle of the said Meridian, for the People in them have the same Hour, with that they have in the given Place. The Globe continuing in that Position, set the Index of the Horary Circle at Noon, and turn the Globe till the Index point at Midnight, and observe what places are then in that Semi-Circle of the Meridian, for the Inhabitants of those places do reckon their Hours contrary to those in the given place.

P R O B.



P R O B. XXVI.

*The Hour of the Day being given in any place, to find those places of the Earth, where it's either Noon or Midnight, or any other particular Hour at the same time.*

**B**Ring the given place to the brazen Meridian, and set the Index of the Horary Circle at the Hour of the Day in that place. Then turn about the Globe till the Index point at the upper Figure of 12, and observe what places are exactly under the upper Semicircle of the brazen Meridian, for in them its Mid-day at the time given. Which done, turn the Globe about till the Index point at the lower Figure of 12, and what Places are then in the lower Semicircle of the Meridian, in them it's Midnight at the given time. After the same manner we may find those Places that have any other particular Hour at the time given, by moving the Globe till the Index point at the Hour desir'd, and observing the places that are then under the brazen Meridian.

P R O B. XXVII.

*The Day, and Hour of the Day, being given, to find those Places on the Globe, in which the Sun then riseth. 2. Those in which he then setteth. 3. Those to whom its Mid-day. And Lastly, Those Places that are actually enlightned, and those that are not.*

**F**Ind that place of the Globe, to which the Sun is vertical at the given time, and bringing  
D d 3 the

the same to the brazen Meridian, elevate the Pole according to the Latitude of the said Place. The Globe being fixt in that Position, observe what places are in the Western Semicircle of the Horizon, for in them the Sun riseth at that time. 2. Those in the Eastern Semicircle, for in them the Sun setteth. 3. Those that are exactly under the Brazen Meridian, for in them it's Mid-day. And *Lastly*, All those upon the upper Hemisphere of the Globe, for they are actually enlightned, and those upon the lower are then in Darknes, or deprived of the Sun at that very time.

P R O B. XXVIII.

*The Month and Day being given, as also the Place of the Moon in the Zodiack, and her true Latitude, to find thereby the exact Hour when she shall rise and set, together with her Southing (or coming to the Meridian) of the given Place.*

**T**HE Moon's place in the Zodiack may be found ready enough at any time by an ordinary Almanack, and her Latitude, (which is her distance from the Ecliptick) by applying the Semicircle of the Position to her place in the Zodiack. For the Solution of the Problem, elevate the Pole according to the Latitude of the given place, and the Sun's place in the Ecliptick at that time being found, and mark'd with Chalk, as also the Moon's place at the same time: Bring the Sun's place to the Brazen Meridian, and set the Index of the Horary Circle at Noon, and turn the Globe till the Moon's place successively



fively coincide with the Eastern and Western side of the Horizon, as also the brazen Meridian, and the Index will point at those various times, the particular Hour of her Rising, Setting, and Southing.

P R O B. XXIX.

*The Day and Hour of either a Solar or Lunar Eclipse being known, to find by the Globe all those Places, in which the same will be visible.*

**M**ARK the Sun's place in the Ecliptick for the given Day, as also the opposite Point thereto, which is the place of the Moon at that time. Then find that place of the Globe to which the Sun is vertical at the given Hour, and bring the same to the Pole (or vertical point) of the wooden Horizon, and fixing the Globe in that Situation, observe what places are in the upper Hemisphere, for in most of them will the Sun be visible during the Eclipse. As for the Lunar Eclipse, you are to find the Antipodes of that place, which hath the Sun vertical at the given Hour, and bringing the same to the Pole of the wooden Horizon, observe (as formerly) what places are in the upper Hemisphere of the Globe, for in such will the Moon be visible during her Eclipse, except those that are near unto, or actually in the Horizon.

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# PROBLEMS

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## Useful in the ART of NAVIGATION.

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### The INTRODUCTION.

**T**Here be Four things upon which the Practice of *Navigation* is principally grounded, viz. 1. *Longitude*. 2. *Latitude*. 3. *Course*. 4. *Distance*.

As for the *Longitude*, though it may be found by the other, yet hitherto there hath not been published any general Rule true and practicable, whereby the *Longitudes* of Places may be immediately and ordinarily found out of themselves.

The *Latitudes* of Places, may be immediately found out by Observation of Sun or Stars, as shall be shewed hereafter.

The third thing to be considered in the Art of Navigation, is the *Course* or Line by which the Ship must go, which dependeth upon the Winds; the Designation of these, upon the certain knowledge of one Principal, which, considering the Situations of the Earth, ought to be North or South, which now is found by the Needle touched with the Loadstone, being thereby endued with

with such a Magnetical Vertue, that if left to its Liberty, 'twill seat it self in a Situation North or South. The North and South-Wind thus assured by the Motion of the Needle, the Mariner supposeth his Ship to be upon some Horizon or other, the Center thereof is the Ship; so that crossing this North and South Line at *Right Angles*, sheweth the East and West; so you have the four Cardinal Winds; Cross each of these, and you have the 8 whole Winds; Another Division makes 16, which again divided makes 32 in all: And these Lines (which a Ship following the Direction of the Magnetical Needle describes upon the Surface of the Water, were by the *Portugals* called *Rumbs*, and is still continued. These *Rumbs* are represented upon the Globe by those *Helispherical* or *Spiral Lines* that you see divided into 32 parts, with a Flower-de-luce always pointing to the North.

The finding of the *Rumb* and *Distance* of a Ship from any place from whence she hath departed, is the last of the four things propounded as necessary in this Art of Navigation; which how to perform, shall be also shewed in the following *Problems*, useful in the *Art of Navigation*.

PROB.



## P R O B. I.

## To find the Latitude.

I. By the Sun's Declination, and Meridian-Altitude.

<p><b>W</b>hen the Sun is in the Equinoctial, having no Declination, and the Meridian-Altitude is observed on the</p>	South-side of the Meridian.	<p>The Meridian-Altitude taken from 90 degr. leaves the Elevation of the North-pole.</p>
	North-side of the Meridian.	<p>The Meridian-Altitude taken from 90 degr. leaves the Elevation of the South-pole.</p>

<p>When the Sun's Declination is</p>	<p>North</p>	<p>If the Meridian Altitude be less than 90 deg. and the Sun upon the South-side of the Meridian, the Sun's Declination being taken from the Meridian Altitude, leaves the height of the Equinoctial; which taken from 90 deg. gives the Latitude North.</p>
	<p>South,</p>	<p>If the Meridian Altitude be less than 90 deg. and the Sun upon the South-side of the Meridian, add the Meridian Altitude and the Declination together, their Sum is the height of the Equinoctial; which taken from 90 deg. leaves the Latitude North. But if the Sum of the Declination and Altitude exceed 90 deg. take 90 therefrom, the remainder is the Latitude South.</p>

When

When the Sun's Declination is

North,

If the Meridian Altitude be less than 90 deg. and the Sun upon the South-side of the Meridian, add the Altitude and Declination together, their Sum is the Height of the Equinoctial; which taken from 90 deg. leaves the Latitude South. But if the Sum be above 90 deg. take 90 deg. therefrom, the remainder is the Latitude North.

South,

If the Meridian Altitude be less than 90 deg. and the Sun upon the North-side of the Meridian, subtract the Declination from the Meridian Altitude, the remainder is the height of the Equinoctial; which taken from 90 deg. leaves the Latitude South.

When the Sun's Declination is

North,

if the Meridian Altitude be just 90 deg.

the Sun's Declination is the Latitude

North.

South.

If the Meridian Altitude be observed under the Pole, within the Bounds of the Polar Circles, in such Case the Sun's Declination must be taken from 90 deg. and what remains is his distance from the Pole; which being added to the Meridian Altitude, the Sum is the Latitude of the place.

¶ Note here, that whatsoever is said concerning finding of the Latitude by the Sun's Declination and Meridian Altitude, the same is to be performed by the Meridian Altitude of any known Star; and the manner how to effect it, will be best seen by the Globe.

II. By



## II. By the Meridian Altitude of a known Star.

Suppose that being at Sea I should observe *Algol* to be upon the South-side of the Meridian, and to have *Altitude* 62 deg. and I would know in what Latitude I then was.

*Arithmetically.*

The Declination of *Algol* is 39 deg. 39 min. North, the Complement whereof is 50 deg. 21 min. his Distance from the Pole; add this distance and his *Altitude* 62 deg. together, the Sum is 112 deg. 21 m. which taken from 180 deg. leaves 67 deg. 39 min. for the Latitude of the place North.

*By the Globe.*

Bring *Algol* to the Meridian, and from the Center of the Star, downwards, count his *Altitude* 62 deg. and mark that Point upon the Meridian; then bring that point to the South-part of the Horizon, and you shall find the North-pole to be elevated 67 deg. 39 m. which is the Latitude you are then in. In like manner, if you should observe

		d.	m.
The Bulls Eye	} upon the South-part of the Meridian, having Altitude	51	0
Spica Virginis		32	0
The Great Dog		72	0

	d.	m.
} you would be in Latitude	54	48 N.
	67	31 S.
	34	14 N.

## III. By

III. *By observing of two Stars, one being upon the Meridian, and the other Rising or Setting.*

Bring the Star which you see upon the Meridian unto the Meridian, and there holding the Globe fast, move the Meridian in the *Horizon*, till you see the other Star on the East or West, Rising or Setting, as you observed it, and then shall the Globe stand at the Latitude you are in.

So if you should see *Regulus* upon the Meridian, and *Lyra* rising towards the East, the Latitude will be found 37 deg. 50 min.

IV. *By the Altitude of two known Stars, being both of them upon the same Azimuth or point of the Compass.*

Lay the Quadrant of Altitude, or rather your thin brass Semicircle to both the Stars, at the proper Degrees of Altitude, as you observed them to be in the Heavens; (for the difference of their Altitudes is equal to their Distance.) Then turn the Globe about in the Horizon, till the Quadrant or thin Plate of Brass, do touch the Horizon in that *Azimuth* (or Point of the Compass) on which you observed the Stars to be, so shall the Globe rest at the Latitude you are in.

So *Capella* and *Scheder*, *Capella* being 20 deg. high, and *Scheder* 66 deg. high, and both of them upon the North-East-point of the Compass, you will find your self to be by this Observation in the Latitude of 40 deg. 0 min. North Latitude.

V. By

V. *By the Altitude, Azimuth, and Declination of the Sun, or of a known Star.*

Suppose a *Fixed Star*, as that in the right Knee of *Hercules*, having 47 deg. 9 m. of *Declination*, should be observed at Sea to have 122 deg. of *Azimuth* from the North part of the Meridian, and to be 60 deg. high; and from hence the Latitude were required:

Elevate the Globe to the Stars Altitude 60 deg. and from the Pole count the Complement thereof 30 deg. to which screw the Quadrant of Altitude: Also count 122 deg. upon the Horizon from the North-part of the Meridian, and to those Degrees bring the Quadrant of Altitude, and there keep it; then turn the Globe about till 47 deg. 9 min. the Stars Declination (counted upon the Equinoctial Colure from the Equinoctial) do cut the Quadrant of Altitude, and those Degrees will cut the Quadrant of Altitude in 71 deg. 13 min. and that is the Latitude in which you then are.

VI. *By the Suns, or a Stars Declination and Amplitude.*

Let the Sun or a Star have 10 deg. of North Declination, and let the Amplitude thereof at its Rising or Setting be observed to be 57 deg. from the North.

Elevate the Globe to 33 deg. (the Complement of the Amplitude) and count the Amplitude it self 57 deg. upon the Meridian from the Pole forward, and thereto screw the Quadrant of Altitude, and bring the other end thereof to the East or West points of the Horizon; then count 80 deg.



deg. (the Complement of the Stars or Suns Declination) from the Pole upon the Equinoctial Colure, and bring those Degrees to the Quadrant of Altitude; so shall 80 deg. of the Colure cut 71 deg. 24 m. of the Quadrant, and that is the Latitude you are then in.

*VII. By the Sun's Ascensional Difference and Amplitude.*

If the Ascensional Difference be 27 deg. 7 min. and the Amplitude 33 deg. 20 min. and the Latitude were required:

Elevate the Globe to 27 deg. 7 min. the Ascensional Difference, and from the Pole count the Complement thereof 62 deg. 53 min. and thereto screw the Quadrant of Altitude; then bring the Equinoctial Colure to the Meridian, and count upon the Quadrant of Altitude upwards, the Complement of the Amplitude 57 deg. 40 m. which degrees bring to the Equinoctial, and then shall the Quadrant of Altitude cut upon the Horizon 51 deg. 30 min. counted from the East or West, which is the Latitude of the place.

And if you count the Degrees of the Equinoctial comprehended between the Meridian and the Quadrant of Altitude, you shall find them to be 20 deg. 5 min. which is the Suns Northerly Declination at that time.

*VIII. By the Sun's or a Star's Declination, and the time that he is upon the East or West Points of the Compass.*

Let the Sun or a Stars Declination be 15 deg. North, and let the time that the Sun is upon the East

East or West Points of the Compass, be 59 deg. 45 min. which in time is 3 hours 56 m. and hence let the Latitude be required.

Elevate the Globe to 15 deg. the Declination, and screw the Quadrant of Altitude to 75 deg. the Zenith Point, then count 59 deg. 45 min. or 3 Hours 56 m. (the Hour) upon the Horizon from the South, Eastward or Westward; and thereto bring the Quadrant of Altitude: Then look what Degrees of the Quadrant are cut by the Equinoctial, and you shall find 28 deg. counted from the Zenith, and that is the Latitude sought.

And thus have you several ways, both by the Sun and Stars, to find the Latitude at any time. I will now proceed to some other Problems for finding the Rumb and Distance, which as was said, is the last of the four things necessary in the Art of Navigation.

## P R O B. II.

*Any two Places given, to find their Rumb.*

*Defini-* **T**Hose Lines which a Ship, following  
*tion.* the Direction of the *Magnetical Needle*, describeth on the Surface of the Sea, are called *Rumbs*, and are (as was said) described upon the Terrestrial Globe by certain *Spiral Lines*; for the better understanding whereof, I shall premise these few Propositions:

*First*, The Needle touched with the Loadstone pointeth out the common Intersection of the Ho-

*rizon*



*rizon* and *Meridian*; the one respecting the North, and the other the South, as aforesaid.

*Secondly*, A Circle drawn through the *Vertex* of any place that is distant from the Equator, cannot cut divers Meridians at equal Angles.

*Thirdly*, A great Circle drawn through the Vertical Point of any place, and enclining to the Meridian, maketh greater Angles with all other Meridians, than with that from whence it was drawn.

*Fourthly*, If we Sail upon any Point of the Compass except North or South, we often change our Horizon and Meridian.

*Fifthly*, The same *Rumb* cutteth all Meridians of all Places at equal Angles, and respecteth the same Quarters of the World in every Horizon.

*Sixthly*, The Portions of the same *Rumb* intercepted between any two Parellels, whose difference of Latitude is the same, are also equal to each other: therefore an equal Segment of the same *Rumb*, equally changeth the difference of Latitude in all places; so that in an equal Space passed in one and the same *Rumb*, one of the Poles is equally elevated, and the other depressed.

*Seventhly*, *Rumbs* though never so far continued, do not pass through the Poles, but wind about the Poles until they lose themselves.

Hence you may understand if your Ship be directed under the *North* or *South-Rumb*, your Course will be always under the same Meridian; if under the *East* or *West-Rumb*, you will either describe the Equator, or a Circle parallel to it: If your Vertical Point be under the Equator, your Ship will describe an Arch or Segment of the Equator; but if your Zenith or Vertical Point be

distant from the Equator either North or South, your Course will then describe a Parallel as far distant from the Equator, as the Latitude of the place is whence you first set forwards: But if your Voyage be to be made under the *Rumb* which inclineth to the Meridian, your Course will then be neither in a greater or lesser Circle, but your Ship will describe a kind of crooked or Spiral Line.

*Practice.*] Find the two places upon the Globe, and when you have found them, see what one Rumb-line passeth through both of them, and that is the Rumb or Point of bearing of those two Places one from the other. So *C. del Gade* on the Coast of *Zanguebar* and *C. Comorin* are both of them found upon the W. S. W. and E. N. E. Rumb, and that is their Point of bearing, or Rumb required.

If you can find no one Rumb that passeth through both your places, then you must look what Rumb-line upon the Globe runneth most parallel to both the given places, and conclude that to be the Point or Rumb of those two places bearing one from another. So if the two places were *Sierra Leona* in *Africa*; and the Island *S. Helena*, if you look upon the Globe you shall find no one Rumb-line to pass through both the places, but that Rumb to which the places lie most parallel, is the N. N. W. and S. S. E. Rumb; and so *Sierra Leona* bearing from *S. Helena* N. N. W. and on the contrary, *S. Helena* is situate from *Sierra Leona* S. S. E. which is the Rumb required.

P R O B. III.

*Having the Distance sailed, and the Rumb you have sailed upon given, to find the difference of the two Places both in Longitude and Latitude.*

**H**AVING found the *Rumb* upon which you made your Course, make a small Mark thereupon, for the Place you departed from; then from the Equinoctial, take the number of Miles or Leagues you have sailed upon that *Rumb*, (allowing 20 Leagues for a Degree) and set that Distance upon the *Rumb* from the former Point made; and at the termination of your number of Miles or Leagues, make a second Mark upon the *Rumb*: then bringing the Place, or Point, you departed from, to the Meridian, you shall there find the Latitude of that Place or Point, and the Meridian cutting the Equinoctial, will shew you the Longitude of that Place or Point.—Do so by bringing the second Point or Place to the Meridian, and there shall you find the Latitude, and upon the Equinoctial the Longitude of that place or point. Now if you subtract the lesser Latitude from the greater, you have the difference of Latitude; and the lesser Longitude subtracted from the greater, gives the difference of Longitude.



## P R O B. IV.

*The Latitude of two places, and the Rumb that the two places bear each from other given, to find the difference of Longitude of those two places, and also their Distance upon the Rumb.*

*Practice.* **F**irst, find the *Rumb* upon the Globe, and turn the Globe about till that *Rumb* doth cut the Meridian in the Latitude of the first place, from whence you departed, and there make a Mark or Point upon the *Rumb*, and at the same time see also what Degrees of the Equinoctial are cut by the Meridian; for that is the Longitude of the first Point.

Secondly, Turn the Globe about, till the same *Rumb* does cut the Meridian in the Latitude of the second place, and there make another Mark upon the *Rumb*; and also see what Degrees of the Equinoctial are cut by the Meridian, which Degrees are the Longitude of the second point or place; and the lesser Longitude being subtracted from the greater, gives the difference of Longitude of the two places or points.

Then for the Distance of the *Rumb*; the Distance between the two points before made, being measured upon the Equinoctial, and reduced to Miles or Leagues, shall give the Distance upon the *Rumb*.

¶ Here note, that the Distance of the *Rumb* being intirely taken and applied to the *Equinoctial*, will give the Distance in the Arch of a great Circle, and not really in the *Rumb*, for the

the Distance upon the *Rumb* will be always greater, than the great Circular Distance : Wherefore the better way will be, to take in a pair of Compasses one, two, three (or some small number of) Degrees of the *Equinoctial*, and run that Distance over upon the *Rumb-line* from point to point ; and the number of all those Returns of the Compasses (reduced to Miles or Leagues ) shall be the near Distance of the two places upon the *Rumb*.

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## Advertisement.

**M**Any other Problems, relating to the Motion of the Sun and Stars might be proposed, which he that is but any thing Ingenious will from the Solution of these often meet with, and from a little Consideration may presently conceive how they are to be solv'd by the Globe, and therefore I count it rather Tautology and burdensome, than beneficial to insert them; a few Examples in things of this Nature being much better than a Multitude, which confounds the Memory, and hinders from having so right and true a Notion of them. Therefore I have not troubled my Reader with Examples to every Problem, hoping the Precepts are so plain, that they need none. However, that I might not be altogether deficient, I have added a Table, which begins the first of *January*, and shows for every 10th Day afterwards the Sun's Place, Declination, Right Ascension, Oblique Ascension, Amplitude from the South, time of Sun's Rising and Setting, time of Twilights beginning and end; and from these several other things are found; as, Ascensional Difference, Length of the Day and Night, Duration of Twilight; so that if for any Day, any of the forementioned things be required to be found by the Globe, 'tis but seeking in this Table for the Day proposed, or the nearest to it, and right against it in the several Columns you have the Sun's Place, Declination, right

Right Ascension, &c. as the Titles at the top of the Columns inform you.

Suppose the Sun's Place, Declination, right Ascension, &c. were required for *September 18*. Find (in the first Column) the 18th of *September*, then right against it in the second, you have  $6^{\circ} 17'$  of *Libra* the Sun's place for that Day. In the third Column is  $2^{\circ} 23'$  which is his Declination. Against the said Day in the 4th Column is  $185^{\circ} 30'$  his Right Ascension. In the 5th Column is  $188^{\circ} 30'$  his Oblique Ascension, from which, if  $185^{\circ} 30'$  his right Ascension be taken, there will remain  $3^{\circ} 00'$  his Ascensional Difference, which difference converted into time at 4 minutes to a Degree, gives 12 Minutes the time that the Sun rises and sets after and before 6. In the 6th Column is  $86^{\circ} 49'$  his Amplitude of Rising and Setting from South, which  $86^{\circ} 49'$  taken from 90, leaves  $3^{\circ} 11'$  his Amplitude from the East Southward. In the 7th Column is 6 h. 11 m. 6 h. which shows that the Sun rises 11 Minutes after 6, and sets 49 Minutes after 5. Now if 5 h. 49 m. the time of his setting be doubled, 'twill give 11 h. 38 m. the length of the Day, which 11 h. 38 m. taken from 24, leaves 12 h. 22 m. the length of the Night. Lastly, in the 8th Column you have 4 h. 19 m. which shows that 19 Minutes after 4 in the Morning, is the time of Twilight's beginning, and this time of Twilight's beginning, taken from 6 h. 11 m. the time of Sun rising, leaves 1. 52. the time of Twilight's Continuance; also if you double the time of Twilight's beginning in the Morning, 'twill give you the Length of the quite dark Night. Next for the Sun's Depression at Midnight, add  $2^{\circ} 23'$  his present Declination to  $38^{\circ}$

28' the Complement of Latitude it makes  $40^{\circ} 51'$ .

If you would know what Day is of equal Length to the 18th of *September*, then find out in the Column of Declination, the same South Declination, or nearest to it, that the Sun had the 18th of *September*, and right against it is *March* the 2d, (for the nearest Declination to it is  $2^{\circ} 47'$ ) which Day is nearly of the same length with the 18th of *September*.

If you would find out the Number of Days contained betwixt the Days of Lengthning or Shortening one Hour: Suppose I would know how many Days after the 18th of *September* 'twill be ere the Day is an Hour shorter. Against the 18th of *September* I find the Sun to rise at 6 h. 11 m. trace down the said Colum till you find the Sun to rise half an hour later; but finding it not to rise precisely half an hour later on any of the Days in this Table; I therefore make a proportional Reduction, by which I find, that about the 2d Day of *October* the Sun will rise at 6 h. 41 m. Now betwixt *September* 18. and *October* 2. is 14 days, the Time betwixt the Days lengthening and shortning one Hour at that time of the Year.

I have here also for the like Reason, added a Table of Longitude, Latitude, Right Ascension, Declination, Cosmical Rising, Achronical Rising of 20 of the most eminent fixt Stars; by which most of the preceding Questions relating to the Stars may be answered; the use of which is evident from the use of the former.



A TABLE shewing from the first Day of January, to every 10th day afterwards, the Sun's place, also his Declination, Right Ascension, Oblique Ascension, Amplitude of Rising and Setting, time of Rising and Setting, and Time of Twilight's Beginning and Ending.

Month	Sun's	De-	R. Af-	Obli.	Amp. of	time of	Begin.	
Days.	place.	clin.	cent.	Ascen.	ris. & set	of ris.	oftwi-	end
	°	'	°	'	°	b. m. h.	b. m.	h.
Jan. 1	♈ 21.25	21.51	292.42	323.03	050.48	8.01.4	5.54	7
11	♈ 01.35	19.45	304.16	331.27	056.15	7.48.5	5.43	7
21	♈ 11.44	17.14	314.28	337.27	062.20	7.31.5	5.35	7
31	♈ 21.51	14.12	324.22	342.58	065.43	7.14.5	5.17	7
Feb. 10	♉ 01.55	10.47	334.00	347.53	072.21	6.55.6	5.00	7
20	♉ 11.57	07.04	343.24	352.25	078.50	6.35.6	4.45	8
Mar. 2	♊ 22.55	02.47	353.35	357.06	085.14	6.16.6	4.20	8
	N.							
12	♊ 02.50	01.11	002.45	001.14	091.35	5.56.7	3.59	9
22	♊ 12.41	05.08	011.57	005.26	097.58	5.36.7	3.34	9
Apr. 1	♊ 22.29	08.35	020.19	009.46	104.24	5.17.7	3.05	9
11	♋ 02.14	12.11	029.48	014.10	109.17	4.48.8	2.38	10
21	♋ 11.56	15.28	039.32	019.10	114.17	4.40.8	2.02	10
May 1	♋ 21.35	18.18	049.34	024.58	119.24	4.24.8	1.30	11
11	♋ 01.11	20.24	058.50	030.54	123.45	4.08.8	0.30	12
21	♋ 10.46	22.08	069.25	038.35	128.23	3.57.9	Twilight	
31	♋ 20.20	23.07	079.06	046.26	129.12	3.50.9	all	
June 10	♌ 29.52	23.30	090.00	056.48	130.26	3.47.9	Night.	
20	♌ 09.24	23.11	099.47	067.10	129.12	3.49.9		
30	♌ 18.27	22.08	110.34	079.46	128.23	3.56.9		
July 10	♌ 28.30	20.24	121.09	093.13	123.45	4.07.8	0.42	12
20	♍ 08.04	18.18	130.25	105.48	119.24	4.21.8	1.22	11
30	♍ 17.39	15.28	140.27	120.03	114.17	4.36.8	2.00	10
Aug. 9	♍ 27.17	12.32	149.13	132.58	107.37	4.53.8	2.21	10
19	♍ 6.58	08.57	158.43	147.17	104.24	5.12.7	3.00	9
29	♍ 16.41	05.08	168.02	161.32	097.53	5.31.7	3.30	9
Sept. 8	♎ 26.27	01.35	176.19	174.20	093.11	5.51.7	3.59	9
	S.							
18	♎ 6.17	02.23	185.30	188.30	089.49	6.11.6	4.19	8
28	♎ 16.10	06.18	194.43	202.44	080.27	6.30.6	4.48	8
Octo. 8	♏ 26.06	10.04	204.05	217.00	073.49	6.50.6	5.00	7
18	♏ 6.06	13.33	213.40	231.20	067.24	7.09.5	5.18	7
28	♏ 16.08	16.40	223.31	245.39	072.20	7.27.5	5.37	7
Nov. 7	♏ 26.14	19.18	233.39	259.59	058.51	7.43.5	5.45	7
17	♐ 6.22	21.21	244.06	273.37	055.18	7.57.5	5.54	7
27	♐ 16.31	22.51	255.52	287.57	050.48	8.07.4	5.57	7
Dec. 7	♐ 26.42	23.27	266.43	299.52	050.48	8.12.4	6.00	8
17	♐ 6.54	23.18	277.37	310.30	050.48	8.12.4	5.58	7
27	♐ 17.05	22.24	288.36	319.44	051.37	8.06.4		

*A TABLE containing the Longitude, Latitude, Declination, right Ascension of 20 of the principal Fixt Stars for the Year 1700.*

Stars Names.	Longi- tude.	Lati- tude.	De- clin.	Right Ascen.	Cosm. rising.	Aerho. rising.	Magn.
<i>Arcturus.</i>	♌ 20. 2.20	♏ 1. 2. 1	20.50	210.30	Sept. 15	Mar. 12	1
<i>Allore in the Harp</i>	♏ 11. 6.20	♏ 1.47.0	38.32	276.45	never.	sets.	1
<i>Capella.</i>	♏ 17.39.20	22.50. 1	45.38	73.30	never.	sets.	1
<i>Aldebaran.</i>	♏ 5.35.50	5.31.0	15.42	64.45	May 27	Nov. 27	1
<i>Cor Leonis.</i>	♏ 5.35.50	0.26.0	13.26	148.00	Aug. 8	Febr. 5	1
<i>Cauda Leonis.</i>	♏ 17.26.20	12.18.0	16.16	173.30	Aug. 22	Apr. 20	1
<i>Spica Virginis.</i>	♏ 19.39.20	1.59.0	9.32	197.30	Octob. 3	Mar. 31	1
<i>Antares.</i>	♏ 5.32.10	4.27.0	25.40	242.45	Nov. 22	May 21	1
<i>Fornahant.</i>	♏ 29.34.50	21.00.0	31.09	340.13	May 4	Nov. 5	1
<i>Rigel.</i>	♏ 12.40.20	31.11.0	8.35	75.00	July 3	Jan. 1	1
<i>Acarnar.</i>	♏ 10.50.10	59.18. 1	58.57	20.45	never.	rises.	1
<i>Sirius.</i>	♏ 9.58.50	39.30.0	16.17	98.00	July 30	Jan. 26	1
<i>Canopus.</i>	♏ 10.51.10	75.48.0	52.28	94.30	never.	rises.	1
<i>Hydra's Heart.</i>	♏ 23. 8.50	22.24.0	7.23	137.45	Aug. 20	Febr. 16	1
<i>Centaurus.</i>	♏ 25.44.10	42.23.0	59.30	210.00	never.	rises.	1
<i>Marshall.</i>	♏ 19.19.50	19.26.0	13.38	342.30	Jan. 5	Aug. 7	2
<i>Procyon.</i>	♏ 21.41.50	15.57.0	6.00	111.00	July 18	Jan. 15	2
<i>Pleiades great *</i>	♏ 25.54.22	3.59.0	23.03	52.10	Apr. 21	Octo. 24	3
<i>Pollux.</i>	♏ 19. 6.20	6.38.0	28.43	111.41	June 21	Dec. 22	2
<i>Mirach.</i>	♏ 25.42.20	25.59.0	33.52	12.43	Dec. 25	June 27	2



*An Account of two Voyages delineated upon the Terrestrial Globe by two small prick'd Lines, the one generally Colour'd Red, the other Blue.*

*Capt. Drake's Voyage round the Globe.*

**A**NNO 1577. Decemb. 13. Mr. Francis Drake with five Ships and Barks, and 165 Men, set out from Plymouth, 27 ditto he came to Madagor, where the Natives treacherously got one of his Men. The last ditto he took three Spanish Fishermen, and three Carvels, Jan. 7. he arrived at C. Blanco, and there took a Ship, 27. ditto he came to Mayo, 31. ditto he sailed by S. Jago, where he took a Portugal Prize. Then he crost the Equinoctial; and April 5. discovered the Coast of Brasil, where in a Storm 7. ditto he lost one of his Ships, but 18. ditto he found it again at C. Joy, where the whole Fleet took in fresh Water, and Sea-wolves. Thence he went into Rio Plata, where he took in fresh Water; and Apr. 27. put out to Sea again, and fell in with several Islands abounding with Seals and Fowls. Here he trafiqued with the Natives; May 8. he entred into the Harbour to refresh, where in an Hours time they killed two or three hundred Seals. Here he burnt his Fly-boat. From hence he sailed, and lost the Ship Canter, but finding her again, took all things necessary out of her, and set her adrift. June 20. he harboured in Port S. Julro; 22. ditto, Drake himself went ashore on the

the Main, where he narrowly escaped the Assault of the Salvages. Here he beheaded Mr. *Thomas Doughty*. *August* 20. he fell with the Straits of *Magellan*; 24. *ditto*, he fell with an Island so full of Fowls that could not flye, that in less than a Day he killed above 3000 to victual with. In *September* he entred the South Sea, *November* he came to *la Mocha*, where he lost two Men by the Natives; from thence to *Val parizo*, where he surprized a great Spanish Ship laden from *Perru*, and in it found above 25000 *l.* Sterling in Gold. Then he rifled the Town and Chappel, and sailed to *Coquinbo*, where the Spaniards killed one of his Men. From thence he went to *Tarapaza*, where on the Shore he found a Spaniard asleep, and by him 30 Bars of Silver worth above 3000 *l.* which he took. Thence he sailed to *Arica*, where he found 3 Barks which he rifled, and found in them 11400 *l.* weight of Silver. Thence he sailed for *Lima*, and under way took a small Bark loaded with Linnen. In *Lima* he found 12 Ships which he rifled, and found in one of the Ships a Chest full of Ryals of Plate and rich Silks. Thence he sailed to *Paita*, and thence to *Panama*; but under-way took a Bark laden with Ropes and Tackle, and found in her 80 *l.* weight of Gold, besides a Crucifix of Gold set with great rich Emeraulds. About *C. Francisco* he took a great rich Ship where in he found 13 Chests of Ryals of Plate, 20 Tun of Silver, 80 *l.* weight of Gold, and many Jewels and precious Stones. Shortly after he took another Ship laden with Linnen-cloth, China Silks, and Dishes, and a Falcon of Gold, with an Emerauld in the Breast of it. Thence he sailed to *Aguatulca*, rifled it, and found in it a Bushel of Ryals

Ryals of Plate. Thence to the Isle *Canon*, where he mended and victualled his Ships. Here he espied a Ship which he took, rifled, and let her go. Hence he sailed into the Lat. of 42 Deg. N. in search of a Passage homewards that way, but found it so cold, that he was forced back into the Lat. of 38 deg. where coming on Shore, the People thought they were Gods, made surrender of their Country to the Crown of *England*, which he called *Nova Albion*; Then he set Sail, and *Octob.* 13, till 18. fell with several Islands in the N. Lat. 8. deg. where he trafiqued with the Natives. Thence to *Midanao*, and so to *Java*. Thence to an Island Southward of the *Celebis*. Thence to the *Baratere Java C. Good Hope*, *Siera Leona*, and *Sept.* 26. 1580. he landed in *England*.

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Mr.



## Mr. Cavendish's Voyage round the Globe.

**M**R. Tho. Cavendish a Suffolk Gentleman, An. 1586. June 10. set from out London with two Ships and a small Batk, which he built and furnisht to Sea at his own Charges. The Names of the Ships were the *Desire*, of 140 Tuns, the *Content*, of 60 Tuns, and the Bark the *Hugh Gallant* of 40 Tuns: All man'd with 125 Men. He sailed through the *Chanel* towards *Farteventura*, thence to *C. Blanck*, and so to *Siera Leona*. Sept. 30. he passed the Equinoctial Line Octob. 29 he came to *Brasil*, and coasted till he came to *I. St. Sebastian* where he took in fresh Water, and built a new Pinnacle of 20 Tuns. Decemb. 16. he arrived at *P. Desire*. Jan. 6. he entred the Straits of *Magellan*. On Land they saw many Salvages which would have betrayed them; but they killed and wounded many of them, the rest fled. Feb. 26. they got through the Straits into the *Pacifick Sea*, and coasted till they came to the S. Lat. of 38 deg. March 28. in the Lat. of 33 deg. he felt an Earth-quake at Sea. March 30. he put into the Bay of *Val Pariso*. April 1. he had 10 Men killed and 2 taken Captives by a surprize of the Spaniards. April 5. he left the Bay, and a while the *Content* sailed into another Bay, where she found 300 Tuns of Spanish Wine buried in the Sand, which she loaded her self with, but had like to have lost her Company; yet at *Arica* they all met again, where they found a great Ship and four Barks which they rifled, and then burnt all but one Bark, which he man'd, and called it the *St. George*. April 25. he left *Arica*,

*rica*, and put out to Sea, where he espied a small Bark which he took, and by it understood they were come from *Val Parisa*, and going to *Lima* to give Information of their being on the Coast. *May 6.* he took two Ships, one laden with Meal and Marmalade, the other with Merchants Goods. He loaded his Ships with part of the Goods, the rest with the Ships he burnt. Then he sailed to *Farto Bay*, and burnt the Town. *June 2.* he went to the Island *Puna*, where he trimmed his Ships, and refreshed his Men: Here about 100 Spaniards and 200 Indians assaulted 16 of his Men, and killed 5 or 6. But e're he went, he burnt their Town and 5 Ships, and spoiled all their Fruit on the Ground. *June 12.* he passed the Equinoctial Line, and still sailed Northwards. About *Guatemala* he took a Ship of 200 Tuns with nothing but Ballast in her, which he burnt. The next Day he took and burnt another Ship. *July 28.* he came to *Apuapulco*, and found there a Ship laden with Cocaos, which he took out, and burnt the Ship and Town. *Aug. 13.* in the Lat. of 19 deg. he fell with *Porto de Natividad*, where he took a Post of Advise Prisoner; here he burnt two Ships of 200 Tuns apiece. Then he went to Island *St. Jago*, and drag'd for Pearls, and got good Store. Thence he sailed to the Southermost Cape of *California*, where he lay cruising till *Novemb. 4.* where with the loss of two Men he took the Ship called the *St. Anne the Great*, which was coming from the Philippine Islands, very richly laden. He took what he could of the best Goods, and burnt the rest, being above 600 Tuns of rich Merchandize with the Ship in the Port of *Agua Segra*, where he set 180 Prisoners on Shore. *Novemb. 20.* he set sail towards the *Ladrones*, where



where he arrived in 42 Days. From thence to the *Phillippine* Islands, and thence to *Borneo*, where he arrived *Feb.* 14. Thence to the Straits of *Fara.* *May* 19. he came to *C. Bona Speransa* : *June* 7. to *St. Hellens* : *July* 14. he past the Equinoctial Line : *Aug.* 24. he saw the *Azores* : And *Sept.* 9. he came into *Plymouth* richly laden with good Prize Goods, and having burnt 20 Spanish Ships and several Towns and Villages.

Lastly, I have added three Problems, which were omitted in *Page* 60.

### P R O B. I.

*The Day of the Month, March 20. and the Meridian Altitude of the Sun given 42. d. 25 m. to find the Latitude of the place.*

**B**Y *Prob.* I. you find the Sun's Place  $\gamma$  10. and *Prob.* III. the Declination 3 d. 35 m. North; then you being on the North side of the Equator, you must subtract 3 d. 55 m. from the Meridian Altitude 42. 25. and there remains 38 d. 30 m. for the Height of the Equinoctial above the Horizon, which subtracted from 90, leaves 51 d. 30 m. for the Elevation of the Pole. And thus it follows, that the Latitude of any Place from the Equinoctial is always equal to the Elevation of the Pole; and the Distance between the Zenith and the Equinoctial is the Complement of the Height of the Equinoctial above the Horizon to 90.

P R O B.

P R O B. II.

*The Place of the Sun given, to find the Height of the Pole, the Hour of the Day, the Azimuth and Almicanter of the Sun.*

**T**HIS must be perform'd by the help of a Spherick Gnomon, which is a small Pin or a Needle fixed perpendicularly into a small Basis, with a hollow Concave Bottom, that it may stand upon the Globe. Therefore the Horizon of the Globe being set parallel to the Horizon of the World, as by *Prob. 9.* the Spherick Gnomon set exactly upon the Sun's place, and the Index rectified by *Prob. 9.* move the Globe both on its Axis E. and W. and by the Meridian through the Notches of the Horizon N. and S. till the Spherick Gnomon cast no Shadow on any side thereof; then keeping the Globe unmoved, you have on the Meridian the number of Degrees that the Pole is elevated above the Horizon, the Index on the Hour-Circle will point to the Hour of the Day; and if you apply the Quadrant of Altitude to the place of the Sun, as by *Prob. 18.* you have his Azimuth and Almicanter.

## P R O B. III.

*How you may learn to know all the Stars in Heaven by the Celestial Globe.*

**T**HE Globe, Quadrant of Altitude, Hour Index, rectified as by *Page 31, 32, &c.* and the Horizon plac'd as by *Prob.* turn about the Globe till the Index of the Hour-Circle point at the Hour of the Night on the Hour Circle; then if every Star on the Globe had a hole in the midst, and your Eye were placed in the Center of the Globe, and looking through the Hole of any Star on the Globe, you would see the same Star in the Heavens which that Star on the Globe represents. For from the Center of the Globe there proceeds a straight Line through the Star on the Globe, even to the same Star in the Heavens. Therefore those Stars that are in their Zenith in the Heavens, will then be on the Zenith on the Globe. Those that are in the East, will be East on the Globe; those in the West part of the Heavens, will be in the West on the Globe; and those Stars that are in any Azimuth or Altitude in the Heavens, will at the same time have the same Azimuth or Altitude on the Globe: So that if you see any Star in the Heavens, whose Name you desire to know, observe its Azimuth or Altitude on the Globe, you will find the same Star, and its Name if it has any adjoining to it. The other Stars about it you may easily know by their Situation, finding their Altitude above the Horizon, and the Azimuth or point of the Compass.



pass they bear upon. Thus knowing some of the most eminent Fixed Stars, you may by the Figure and Bearings of the rest, come to the Knowledge of them also.

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*An Advertisement concerning the Projection and Uses of General and particular Maps.*

**A**Lthough the Description of the Earth upon the Globe be most proper to the Understanding, and commensurable to Nature; yet there are several ways to project it in a Plane or Flat. Two especially are now in use, one by *Parallelogram*, the other by *Planisphere*.

*Of the Description by Parallelogram.*

This used to be divided into the midst by a Line drawn from *North* to *South*, representing the great *Meridan*; Cross to this at right Angles another Line was drawn from East to West for the *Equator*. The *Meridians* equally distant, and the *Parallels* also equally extended, and straight Lines; and this way of Projection, tho' utterly against the Original Nature and Constitution of the *Globe*, yet the *plain Charts* are bound to follow; indeed 'tis strange to me that this *Sea-Chart*, being one of the most principal Instruments that the Mariners have for their direction in Sailing, and known to be so greatly

and dangerously erroneous, yet is still made use of by those that would be accounted excellent.

*Of the Description by the Planisphere.*

This other way of Projection, represents the Face of the *Earth* upon a Plane in its own proper Figure Spherically, as upon the *Globe*, the Gibbosity only allow'd for, and this is twofold.

*Of the Section by the Equator.*

Suppose the *Terrestrial Globe* flatted upon the Plane of the Equator, and you have this way of Projection, dividing the Earth into two Hemispheres, *North* and *South*, where the Pole is the Center, the Equator is the Circumference, the Oblique Semicircle from *Aries* to *Libra* is the North-half of the Ecliptick, the Parallels are whole Circles, and the Meridians are straight Lines.

*Of the Section by the Meridian.*

Suppose the *Terrestrial Globe* flatted upon the Plane of the *Meridian* and you have this way of Projection; the Equator is here a straight Line, the great Meridian is a whole Circle, and the lesser Meridians are more Circular as they come near to the great, only that which passeth thro' the midst of the Hemisphere, dividing it into two equal parts, is a straight Line; so that the Meridians do not equally in distance concur, the Parallels are not Parallels indeed, and the Degrees are unequal. However this way is that which is  
now



now most in fashion: it is described by those two great Circles that take up the following Map.

*Of Particular Maps.*

Particular Maps are but Limbs of the Globe; and therefore, tho' they are drawn asunder, yet they are to be made with that Proportion, as a Remembring Eye may suddenly acknowledge, and join them to the whole Body.

They are most commonly described upon a Parallelogram; but it ought to be with such Consideration, that being but Parts and Members severed from the whole, they yet might make as great an Appearance of Integrity and Truth as can be allowed; and ought to consist of such Proportions of Meridians and Parallels, as they truly consisted of in the Globe it self. And because no Countrey is exactly square, so much of the bordering Territories are usually put in, as may shew the Bounds, and fill up the Square also.

The true Projection of *Maps* chiefly consists or depends upon the fore-knowledge of the true *Longitude* and *Latitude* of Places; which having been so notoriously false, 'tis strange to me how the *Maps* can be true. The *Longitude* is to be expressed by *Meridians* from *East* to *West*. The *Latitude* by *Parallels* from *North* to *South*: both which ought to be circular not straight Lines. All these *Maps* should be so projected, that the Top and Bottom of the Square are always North and South, the Right and Left Sides East and West; so that you see each Country and Place in its true Scituation, as in the Globe or general Map; the *Parallels* and *Meridians* should be both circular  
Lines

Lines, so that the *Longitude*, *Latitude* and *Distance* may agree with the Globe, only the *Meridians* are inclining and concurring towards the Poles, to agree to the Nature of the whole, whereof the are such Parts. And here give me leave to advertise, That altho' in small *Maps* the Error is not very discernable; yet certainly the French Geographers, whose *Maps* are now the Fondlings of this Age, did not understand the Projection of the Sphere; for to me it would have been a great Shame to have exposed the Parts of the World so large, upon so false a Basis; which must needs render them intollerably false in the Distances of Places, had the *Longitudes* and *Latitudes* been never so well adjusted; which indeed are as false as the Distances are.

As to the Graduation of Maps, the Degrees of *Latitude* are divided upon the East and West side: The Degrees of *Longitude* upon the North and South. Beginning from the first *Meridian*, and reckoned round upon the Globe to 360 Degrees. But in some *Maps* the Top and Bottom Figures are the Difference of *Longitudes* from the first *Meridian*, and are reckoned East or West, according as the Scituation of the Place is East or West from the first *Meridian*.

For from whence to reckon the *Longitude* in all Maps, is a fault of most *Geographers*; and I am not the first that have complained of it; for though there be a Graduation, yet you are uncertain where their first *Meridian* begins.

*An Advertisement concerning Longitude.*

**B**Y the Table in page 32 you may easily know from whence most Geographers begin their Longitudes, and also know how near to Truth by adding or subtracting the proper Numbers in the Table; to or from the Number found in other Maps.

As to the Scale in particular Maps, it dependeth upon the Degrees of a great Circle, and the proportion of Miles in each Countrey to such a Degree, which I have discoursed of from page 5 to 13.

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**F I N I S.**







